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Work Plan for Additional Assessment Activities, Hazardous Waste Storage Area (Building 560)

AIR CENTER FOR ENVIRONMENTAL EXCELLENCE

Rickenbacker Air National Guard Base
Columbus, Ohio

Prepared For

Air Force Center for Environmental Excellence
Technology Transfer Division
Brooks Air Force Base
San Antonio, Texas

and

Rickenbacker Air National Guard Base
Columbus, Ohio

UNITED STATES AIR FORCE 1947-1997 50 YEARS

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SECTION 1

INTRODUCTION

This work plan describes the additional assessment activities that will be completed at the former Hazardous Waste Storage Area (HWSA), Building 560, Rickenbacker Air National Guard Base (ANGB) in support of preparing a risk-based closure recommendation for soil and groundwater contaminated with petroleum and chlorinated hydrocarbons. This work plan was jointly prepared by Parsons Engineering Science, Inc. (Parsons ES) under contract with the Air Force Air Mobility Command (AMC) and the Air Force Center for Environmental Excellence (AFCEE) and by International Technology Corporation (IT) under a separate contract with AFCEE. Information developed as part of this effort will be used to supplement existing site characterization data, optimize the design of engineering components for site closure, and establish long-term closure objectives for the site.

1.1 PROJECT BACKGROUND AND OBJECTIVES

An important component of the additional assessment activities described in this work plan will be to more fully describe site-related contamination and to assess the degree of contaminant mass and risk reduction achievable through natural attenuation processes and engineered *in situ* treatment approaches. The primary purpose of these proposed activities is to collect sufficient site-specific data to determine the best approach for securing a risk-based closure of the HWSA. Specifically, data proposed to be collected under this work plan will be used to evaluate and select the most cost-effective strategy for effective risk reduction, including natural attenuation of groundwater contamination and targeted source reduction via bioventing, and/or air sparging/addition of oxygen releasing compounds to enhance natural attenuation of dissolved contaminants in groundwater. Data proposed to be collected under this work plan are unique, are not duplicative of any previous efforts, and are critical to establish the most cost-effective risk reduction strategy for the site. Several state-of-the-art data analysis techniques will be used after the data collection phase of this proposed work to quantitatively evaluate and characterize risk reduction requirements and performance objectives.

Recently, an amended closure/post-closure plan (Parsons ES, 1997) for the HWSA was prepared in compliance with the Ohio Administrative Code (OAC) Title 3745 Chapter 66 and the Code of Federal Regulations (CFR), Title 40 Part 265, Subpart G. The amended plan was submitted by the Air Force Base Conversion Agency (AFBCA) to the Ohio Environmental Protection Agency (Ohio EPA) Division of Hazardous Waste Management (DHWM) for approval. The proposed closure approach presented in this plan was intended to supersede an approved 1993 closure approach which was

based on engineered groundwater remediation via extraction and treatment (E&T). The currently proposed closure approach includes:

- Decontamination of Building 560 by cleaning the building and drum wash pad (completed April 1996);
- Removal of remaining underground storage tanks (USTs) (completed February 1995);
- Limited *in situ* remediation of organic soil contamination via passive or forced air-injection bioventing;
- Natural oxidation of residual dissolved fuel hydrocarbons and natural reductive dehalogenation of residual dissolved chlorinated hydrocarbons;
- *In situ* remediation of residual dissolved chlorinated hydrocarbons via groundwater amendment (passive or active oxygenation), as necessary;
- Continued monitoring and site access controls as part of post-closure commitments; and
- Eventual total site exposure control by installation of taxiway (proposed as future land use).

DHWM has approved the amended closure/post-closure plan with few modifications. The additional assessment activities described in this work plan will be used to guide implementation of the final five elements of the proposed closure approach described above, as well as establish risk-based performance objectives (as specified in the modifications of the amended closure/post-closure plan approval) to be used to determine when a sufficiently health-protective remedy has been completed at the site (i.e., when to terminate active closure activities and petition for closure certification). It is important to note that the nature and magnitude of any closure activities will be driven by the risk-based performance objectives. Consequently, the proposed closure strategy could be subject to modification pending identification of appropriate risk-based remediation standards.

AFCEE supports identifying and implementing the most cost-effective risk reduction strategy at sites that require some form of remediation by field testing promising remedial strategies and techniques. One of the remedial strategies currently being sponsored by AFCEE is a nationwide field test of risk-based remedies at large sites contaminated by petroleum hydrocarbons/chlorinated aliphatic hydrocarbons (CAHs). These remedies are called "risk-based," because the scope, nature, and magnitude of the recommended remedial strategy is defined by the need to protect current and reasonable future receptors from exposure to unacceptable concentrations of site-related chemicals. A "risk-based remediation" may include chemical source reduction via engineered techniques (e.g., low-cost bioventing) and/or interrupting/eliminating potential receptor exposure pathways (e.g., documenting the effectiveness of natural attenuation processes, exposure controls).

Documenting the effects of natural attenuation processes, specifically biodegradation, is a critical, but often overlooked, element of completing a quantitative exposure pathways analysis. These data are necessary to assess the need to include engineered remediation techniques into the overall site risk reduction strategy. AFCEE, in concert with the US Environmental Protection Agency's (USEPA's) National Risk Management Research Laboratory (NRMRL) and Parsons ES, has developed two technical protocols that describe how to scientifically investigate and document natural attenuation of both petroleum hydrocarbons and CAHs (Wiedemeier *et al.*, 1995, Wiedemeier *et al.*, 1997). If site-specific data indicate that natural attenuation processes, such as biodegradation and sorption, are occurring at rates which effectively degrade and/or limit the mobility of contaminants and thereby interrupt potential receptor exposure pathways, the Air Force advocates that natural attenuation should play a central role in remedial plans for the site. In most instances, exposure controls and long-term monitoring commitments are necessary complements of natural attenuation.

If such a risk reduction strategy is not likely to achieve a permanent remedy at a specific site in a reasonable time frame, the Air Force has developed guidance on how to investigate the effectiveness of various low-cost engineered source reduction techniques (e.g., bioventing, limited pumping options). These engineered source reduction techniques can be employed to reduce or control any unacceptable risks associated with source area contamination; minimize long-term compliance costs that can be associated with nonintrusive risk reduction techniques; and/or satisfy other requirements such as regulatory direction, public pressure, or to achieve aesthetic goals.

1.2 REGULATORY FRAMEWORK

1.2.1 Site Background

A notification of hazardous waste activity and a Part A (Interim Status) application was submitted to the USEPA by Rickenbacker ANGB on March 22, 1983. The site was granted USEPA Interim Status Permit #OH3571924544, but the application was not processed for Ohio, and a Part B permit application was not submitted (Ohio EPA, 1995). The HWSA was used from 1983 to 1986 for the storage of drummed wastes generated at the Base. Additionally, 15 USTs were formerly located at, or within the vicinity of, Building 560/HWSA.

The following information was summarized from the Comprehensive Groundwater Monitoring Evaluation (CME) conducted by Ohio EPA (1995). A closure plan for Building 560 was submitted to the Ohio EPA on April 15, 1987. The plan was disapproved on April 6, 1988, and a revised closure plan was submitted on July 27, 1988. This plan was approved by Ohio EPA on September 29, 1988. On October 26, 1990, Rickenbacker informed the Ohio EPA that a "clean closure" in accordance with the closure plan could not be achieved. Ohio EPA advised Rickenbacker to continue under the original plan until the vertical and horizontal extent of contamination could be determined.

On May 26, 1992, Rickenbacker ANGB submitted an amended closure/post-closure plan to close the HWSA as a landfill with engineered groundwater remediation to occur

during the post-closure care period. Following Ohio EPA's issuance of a Notice of Deficiency on February 9, 1993, a revised closure/post-closure plan was submitted on March 15, 1993 and was approved by Ohio EPA on July 13, 1993. This plan proposed closure of the HWSA as a landfill with groundwater remediation via E&T. The closure plan also proposed completion of closure without a protective cap due to concerns that a cap would interfere with the groundwater E&T system.

On September 30, 1994, responsibility for closure of the HWSA was transferred from Rickenbacker ANGB to the AFBCA. On January 27, 1995, the AFBCA informed the Ohio EPA that the effectiveness of the proposed groundwater E&T system was being questioned and an extension was requested to allow for a demonstration of the effectiveness of natural attenuation processes at the HWSA. The extension of the closure period was approved by Ohio EPA on March 21, 1995.

The findings of the natural attenuation demonstration project at the HWSA and revised closure recommendations were documented in an October 1995 amended closure/post-closure plan. On August 26, 1996, after review of the October 1995 plan, the Ohio EPA informed the AFBCA that reliance on natural chemical attenuation processes as the sole remedial action for closure would not be approved. Additionally, Ohio EPA noted that risk-based performance objectives should be established to support any closure recommendations.

In response to this technical direction, the AFBCA submitted a revised amended closure/post-closure plan which proposed various source reduction technologies [bioventing, air sparging/oxygen release compound (ORC®) injection]. This plan was submitted to Ohio EPA on October 11, 1996. Following Ohio EPA's issuance of a Notice of Deficiency on January 23, 1997, the plan was modified to correct deficiencies and resubmitted by AFBCA on February 28, 1997. This version of the amended closure/post-closure was released for public comment the week of March 17, 1997. Notification of formal approval of the plan with modifications by Ohio EPA was received on May 19, 1997. Closure plan modifications significant to this work plan include:

- Closure approval of the HWSA as a landfill with all post-closure care requirements being applicable unless it can be demonstrated that risk-based health standards can be achieved at the end of the closure period; and

- Extension of the closure period until October 2000 to allow negotiations with the Rickenbacker Port Authority to ensure that the final closure strategy is compatible with the planned future use of the HWSA.

1.2.2 Regulatory Authority

The 15 USTs formerly located at, or within the vicinity of, the HWSA were removed in 1994 and 1995 and the AFBCA received a "No Further Response Action Plan" (NFRAP) status from the Ohio Department of Commerce, Division of State Fire Marshal, Bureau of Underground Storage Tank Regulation (BUSTR) in March 1996. The NFRAP for four of the USTs (#47-50) was granted for the tanks under the condition that residual contamination in soils and groundwater would be addressed as

part of the closure approach presented in the amended closure/post-closure plan (Parsons ES, 1997).

Closure of the HWSA is being conducted in accordance with Ohio EPA standards for hazardous waste (Resource Conservation and Recovery Act [RCRA]) interim facilities (OAC 3745, Chapters 65 through 69). In accordance with the closure performance standard for interim facilities (OAC 3745-66-11), closure of the facility must:

- Minimize the need for further maintenance;
- Control, minimize, or eliminate to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste/hazardous constituents to groundwater, surface waters, or to the atmosphere; and
- Comply with various other OAC rules regarding closure of interim facilities.

Rules OAC 3745-66-10 to 3745-66-15 outline closure requirements, and OAC 3745-66-16 to 3745-66-20 give post-closure care requirements applicable to all interim hazardous waste facilities. After closure plan approval by Ohio EPA, partial and/or final closure activities typically must be completed within 90 days; however, an extension has been received from Ohio EPA that specifies a closure period until October 2000 as long as adequate steps are taken to prevent threats to human health and the environment (OAC 3745-66-13). The facility owner/operator can amend the closure plan at any time prior to notifying Ohio EPA of partial or final closure (OAC 3745-66-12). In accordance with the currently applicable closure plan (Parsons ES, 1997) post-closure care based on a landfill closure is to begin after completion of closure activities and continue for 30 years. However, Ohio EPA may reduce or extend this post-closure care period based upon whether human health and the environment are sufficiently protected (OAC 3745-66-17). As with facility closure, the owner/operator can amend the post-closure plan any time during the post closure care period (OAC 3745-66-18). In addition, the owner/operator may petition the Ohio EPA to reduce the post-closure care period based on evidence demonstrating that the secure nature of the hazardous waste facility makes post-closure care requirements unnecessary or supports reduction of the post-closure care period (OAC 3745-66-18(G)). Applicable evidence indicating the secure nature of the facility includes leachate or groundwater monitoring results and application of advanced technologies.

1.2.3 Ohio EPA Risk-Based Closure Guidance

Authorization to consider risk assessment, or what constitutes "decontamination" of a site, as a closure option is provided by rule OAC 3745-67-28 which adopts federal regulations 51 FR 16422 and 52 FR 8704, promulgated on May 2, 1986 and March 19, 1987, respectively (Ohio EPA, 1993a). Currently applicable Ohio EPA (1993b) guidance is provided in the *Interim Final Guidance for Reviewing Risk-Based Closure Plans for RCRA Units*. This document states that two options exist for an owner/operator closing a RCRA unit where no further RCRA obligations are required for managing or monitoring the unit:

- Option 1 - Complete removal of waste materials and contaminated soils; or

- Option 2 - Complete removal of waste materials and decontamination of environmental media (soil, water, and air) to health-based standards.

For the second option, demonstration of acceptable decontamination is performed through a human health risk assessment on the contaminated environmental media to be left in place. The risk assessment is to be conducted for all impacted and potentially impacted environmental media.

Site-specific demonstrations of protection of human health and the environment are required for closure by risk assessment (Ohio EPA, 1993b). The owner/operator can propose site-specific, risk-based cleanup and closure strategies which address all routes of exposure and unacceptable risk. Site-specific risk assessment proposals must document that contaminants left in soil will not adversely impact environmental media (groundwater, surface water, or the atmosphere) and demonstrate that direct exposure of receptors through dermal contact, ingestion, or inhalation will not result in a threat to human health and the environment. This approach is consistent with the Air Force's preference to pursue risk-based remediations at petroleum- and/or CAH-contaminated sites.

The Ohio EPA (1993a and 1993b) guidance provides information related to data evaluation and collection, exposure assessment, toxicity assessment, and risk characterization. These guidance documents will be closely adhered to, as appropriate for site assessment activities related to risk-based closure of the HWSA. Ohio EPA DHWM strongly advises against risk assessment assumptions which differ from this guidance, without checking with the DHWM Closure Unit. Consequently, those exposure assumptions that differ from guidance recommendations but are more representative of site conditions will be discussed with Ohio EPA before completion of an amended closure/post-closure plan.

1.2.4 Forthcoming Potentially Relevant Ohio EPA Guidance

Ohio EPA is in the process of revising current policy and procedures on various risk-based guidance issues and developing guidance consistent with DHWM and Division of Emergency Remedial Response (DERR) regulatory objectives. The revised risk-based guidance from Ohio EPA is expected to be finalized by late summer 1997. Issues requiring resolution which may be pertinent to a risk-based closure of the HWSA at Rickenbacker ANGB include:

- Evaluation of leaching-based model(s) for determining leaching of soil contaminants to groundwater;

- Standardization of exposure parameters, including use of the 95 percent upper confidence limit (UCL) to represent site exposure concentration terms in human health risk assessments;

- Development of future land use criteria;

- Evaluation of USEPA's approach to using drinking water maximum contaminant levels (MCLs) in risk assessment;

- Development of criteria that reflect an acceptable carcinogenic target risk range (10^{-4} to 10^{-6});

- Determination of what constitutes an adequate ecological risk assessment;

- Standardization of methods to evaluate data; and

- Development of guidance criteria for evaluating lead and chromium.

Included within the revised risk-based guidance will be the listing of generic risk-based standards developed by Ohio EPA for specific hazardous constituents. Ohio EPA has identified a 10^{-5} cumulative carcinogenic risk goal for generic risk-based standards is acceptable to ensure protection of human health within the Voluntary Action Program (VAP) for DERR sites. For consistency, this target risk goal has also been adopted by other Ohio EPA programs including DHWM programs.

1.3 SCOPE OF WORK

As noted previously, the primary objective of this scope of work is to collect site characterization data and treatability data relevant to implementing a risk-based closure approach for the HWSA at the Rickenbacker ANGB. The nature and magnitude of any remediation/closure activities actually implemented at the site will depend on what is required to achieve complete remediation, pursuant to the findings of a human health risk assessment. The scope of work to be completed is as follows:

- Gather and review existing site characterization and monitoring data and evaluate whether the nature and extent of contamination in soil and groundwater has been adequately defined;

- Collect additional site characterization data to further delineate site-related contamination and assess the effectiveness of natural attenuation processes in reducing the potential for adverse exposure of both human and ecological receptors;

- Field-test at least one source reduction technique (i.e., bioventing, air sparging, or ORC® injection) that may be necessary to supplement nonintrusive risk reduction techniques (e.g., natural attenuation, exposure controls);

- Quantitatively evaluate and compare the cost-effectiveness of source reduction technique(s), alone and in combination, at achieving source reduction and desired risk reduction (i.e., risk-based cleanup standards);

- Perform statistically valid soil sampling if warranted for further risk-based characterization or in the event that the proposed source reduction techniques do not appear to be appropriate for the site;

- Identify a "risk-based remedy" that achieves the desired level of risk reduction for the least cost; and

- Document and present these supplemental findings and conclusions in an amended closure/post-closure plan or other format, as necessary.

The general decision-path, documentation, and tools necessary for implementing the risk-based remediation approach are presented as a flowchart in Figure 1.1.

1.3.1 Confirmation of Contaminant Distribution

Additional site characterization data are required to fully describe the nature and extent of site-related contamination and to assess the potential for natural attenuation processes and engineered risk reduction techniques to minimize contaminant migration within the environment and eventually destroy contaminant mass *in situ*. Supplemental analytical data for each of those chemicals that may significantly contribute to overall site risk (i.e., the chemicals of potential concern [COPCs]) will be collected at additional sampling locations in soil vapor, soil, and groundwater. The chemicals for which new or updated analytical data will be collected are identified in Section 2 of this work plan. Geochemical data relevant to investigating whether site-related fuel and CAH compounds are being effectively attenuated, specifically biodegraded, in impacted environmental media also will be collected.

"Natural attenuation" is considered by the Air Force to be a feasible and defensible risk reduction technique for a specific site when site-specific data indicate that naturally-occurring attenuation processes, specifically biodegradation, can bring about a reduction in the total mass of contamination in a reasonable time frame and before exposure pathways to receptors are complete. In many cases, natural attenuation processes have been effective in reducing contaminant concentrations to below risk-based and/or promulgated chemical-specific remedial goals.

Section 4 of this work plan describes these additional sampling requirements. Emphasis will be placed on collecting data sufficient to support quantitative exposure pathways analyses, developing statistically-valid contaminant trend analyses, and evaluating the feasibility of achieving adequate risk reduction for closure of the HWSA. Data from previous environmental investigations, which are presented in Section 2, will be used as appropriate.

1.3.2 Estimating Potential Risks to Human Health and the Environment

Collection of additional data relevant to defining risk-based performance objectives and remediation goals also are proposed in this work plan. Two basic risk characterization approaches will be pursued as part of this effort; an additional, more sophisticated risk characterization approach may be completed, as necessary, to support the identification of a risk-based remedy for the site. The first basic approach is a chemical-specific approach that involves comparing measured site concentrations to generic risk-based standards to identify COPCs (Section 2). The purpose of this screening evaluation at this stage of project planning is to identify those chemicals which may contribute significantly to cumulative site risk. The results of this initial evaluation will be used to guide and focus additional assessment activities (e.g., define the analytical methods to be run on newly-collected samples). This screening evaluation is <u>not</u> intended to limit the chemicals to be included in the full quantitative risk assessment. The second approach will involve developing a site-specific risk

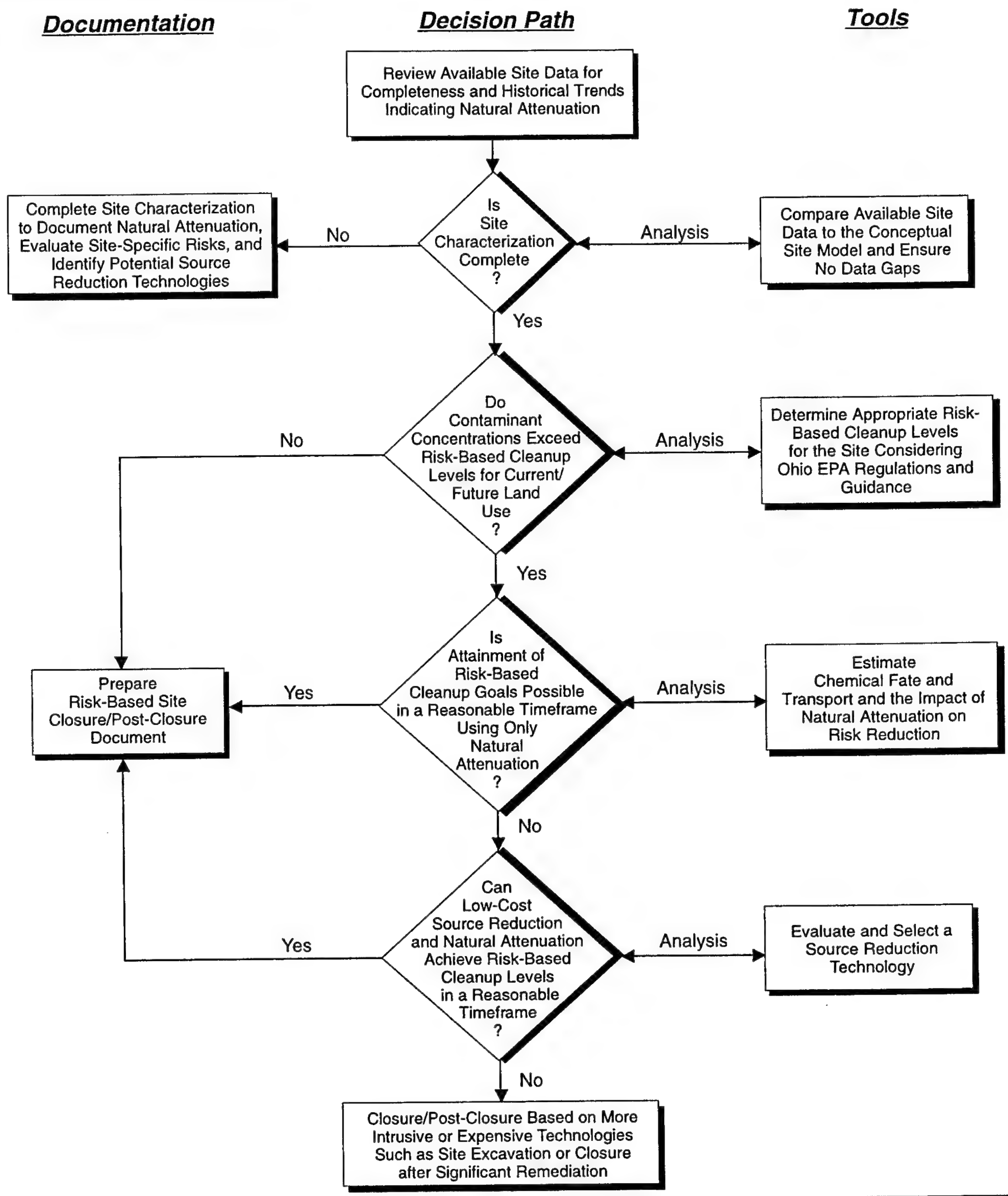

FIGURE 1.1

RISK-BASED REMEDIATION FLOW CHART

HWSA
Rickenbacker ANGB, Ohio

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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assessment to (1) characterize potential cumulative chemical risks, and (2) establish site-specific, health-protective remediation/closure standards. This second approach also is consistent with Ohio EPA's requirements for risk-based closure plans for RCRA units (Ohio EPA, 1993b). The risk characterization information will be incorporated into the remedial/closure planning process to determine the most cost-effective strategy for pursuing complete remediation (i.e., health-protective) of the HWSA.

1.3.3 Treatability Evaluations

Any risk-based remedy proposed for the HWSA will hinge on demonstrating that the implemented risk reduction techniques are adequately protective of reasonable current and potential future receptors. Although contaminant source reduction may not be necessary to reduce potential risks associated with direct exposure to soil, soil vapor, and groundwater in the source area, reduction in source area contaminant mass can minimize long-term compliance costs that can be associated with nonintrusive risk reduction techniques such as natural attenuation, and/or satisfy other requirements such as regulatory direction and public pressure. The proposed activities in this work plan also include field testing at least one innovative source reduction technology that may be appropriate to implement at the HWSA to achieve complete remediation/closure. The emphasis of these technology field tests will be to determine whether the technology can readily and economically achieve the desired risk reduction levels and what uncertainties may be involved in this determination. The specific source reduction technologies which may be field tested at the HWSA include bioventing of vadose zone soils and addition of oxygen (either passive or active) at the leading edge of the dissolved CAH plume to enhance natural oxidation. Section 4 describes the proposed field activities to be completed to test these source reduction technologies.

1.4 WORK PLAN ORGANIZATION

This work plan is oriented toward the collection of site-specific data to be used to complete quantitative analyses of contaminant migration potential and the potential risks associated with residual chemical contamination. This work plan describes the need for additional data and how that data will be collected in the field and then analyzed to determine the most cost-effective risk reduction strategy. Data from proposed treatability studies will be used both to characterize the current nature and extent of chemical contamination and to estimate the effectiveness of additional source reduction activities at the site, should such measures be necessary to achieve site-specific risk-based remediation/closure goals. This work plan also briefly describes the methods of data analysis that will be completed to identify and develop a risk-based remedial/closure plan for the HWSA. This work plan was prepared to coordinate the activities of all agencies involved in this risk-based effort, including AFCEE, Rickenbacker AFBCA, Ohio EPA, Parsons ES, and IT Corporation.

This work plan is based on a review of existing site characterization data and the data needs of a risk-based approach to remediation. The work plan consists of seven sections, including this introduction. Section 2 summarizes existing data on the physical characteristics and nature and extent of those chemicals that exceeded screening criteria at the HWSA. Section 3 presents a conceptual site model and the proposed closure approach, both of which are relevant in identifying additional data needs. Section 4 summarizes existing data gaps and presents the proposed sampling

strategy to collect the required additional site characterization data. Section 5 discusses how existing and new site characterization and treatability data will be integrated to identify the most cost-effective risk reduction strategy. Section 6 presents the proposed project schedule, and Section 7 includes all references used in preparing this document. This work plan also contains two appendices. Appendix A presents the site-specific sampling and analysis plan, and Appendix B presents the site-specific health and safety plan to be followed by IT Corporation during all field and data collection activities.

SECTION 2

REVIEW OF AVAILABLE SITE DATA

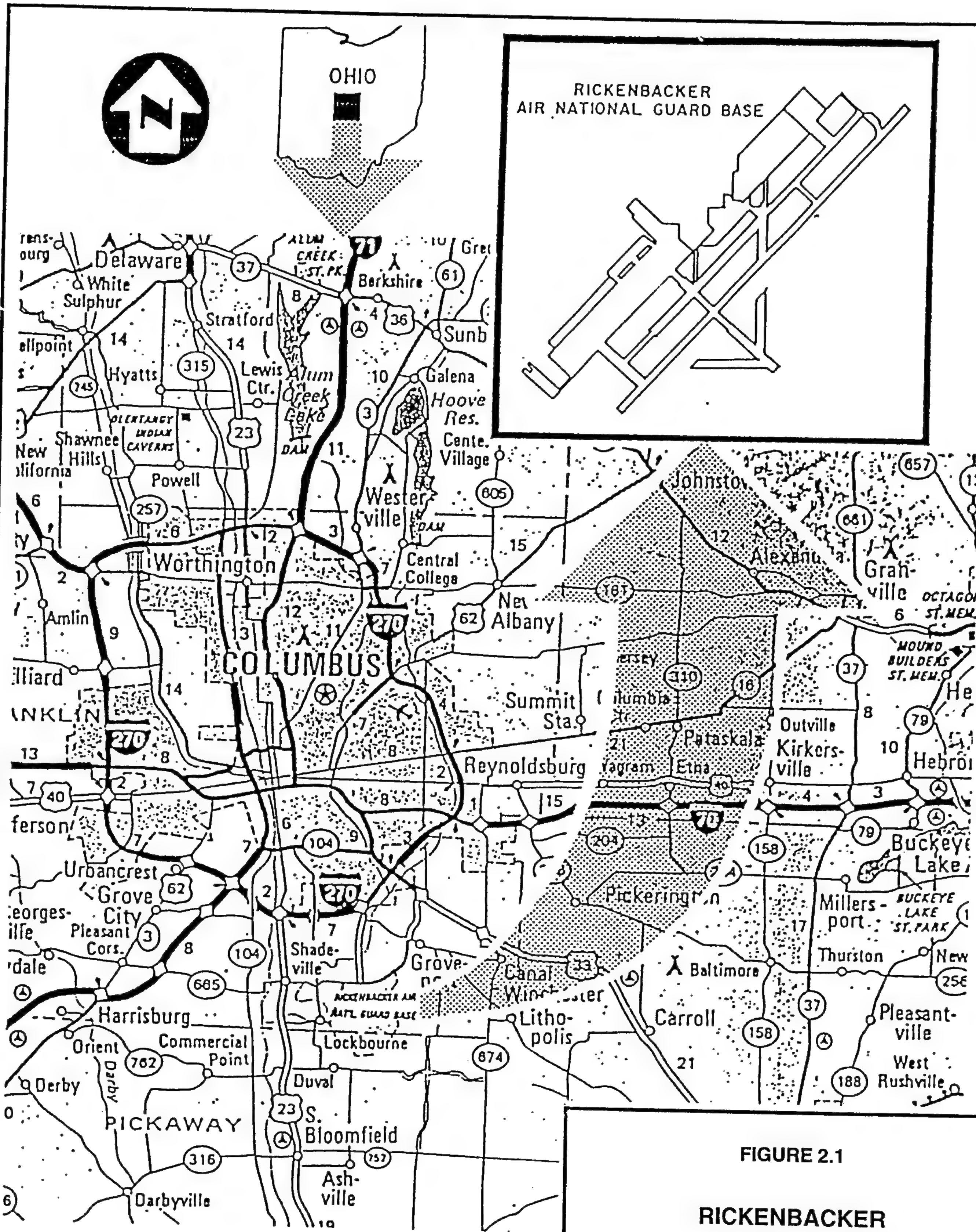
Environmental investigations were conducted at the HWSA in 1989, 1990, and 1991 by Engineering-Science, Inc. (ES) to determine the nature and extent of contamination at the site. To more completely define the extent of contamination and to document the potential feasibility of relying on natural chemical attenuation processes as a potential remedial approach for groundwater, additional field work was conducted in February and March of 1995. Results of quarterly groundwater sampling events, which were completed in August 1995, December 1995, March 1996, June 1996, September 1996, and December 1996 were also considered when evaluating the appropriateness of potential remedial approaches for groundwater.

2.1 SITE BACKGROUND

Rickenbacker ANGB is located 12 miles southeast of Columbus, and 0.5 mile east of Lockbourne, Ohio (Figure 2.1). The base covers approximately 2,100 acres in Franklin and Pickaway Counties and is located on a glacial till plain between the Big Walnut and Walnut Creek drainage basins. The area has been used as an air base under the custody of various government branches, including the Army Air Corps and the Air National Guard since 1942.

The HWSA is located in the central area of the base (Figure 2.2). The area where the HWSA was constructed had various other uses in the past. Historical aerial photographs, maps, and drawings indicate that the site had been used for a storage yard, probably for drummed lube oils. When the base was first constructed in 1942, individual buildings were heated with coal. The coal storage area for the base was located west of the HWSA, adjacent to the railroad tracks. The smokestack for a coal-burning furnace is still standing approximately 180 feet from the HWSA.

The HWSA measures 170 feet by 95 feet, and is surrounded by a chain-link fence with a locking gate (Figure 2.3). A majority of the site is unpaved and vegetated with grasses. There is a paved driveway that leads to the now-decontaminated Building 560, and the floor of the building is paved with concrete. The area surrounding the site is very level and also is vegetated with grasses. To the north and east of the site is a gravel road, and beyond the road are railroad tracks that are no longer in use. The area to the south and west is currently used as a storage yard for stockpiled telephone poles and drummed material. To the south and east of the site are office buildings and parking lots. Beyond the buildings to the east are the base runways. These runways receive air traffic consisting of various military aircraft and private aircraft associated with the Rickenbacker Port Authority.



Sources: ES, 1992

FIGURE 2.1

RICKENBACKER ANGB LOCATION

HWSA
Rickenbacker ANGB, Ohio

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

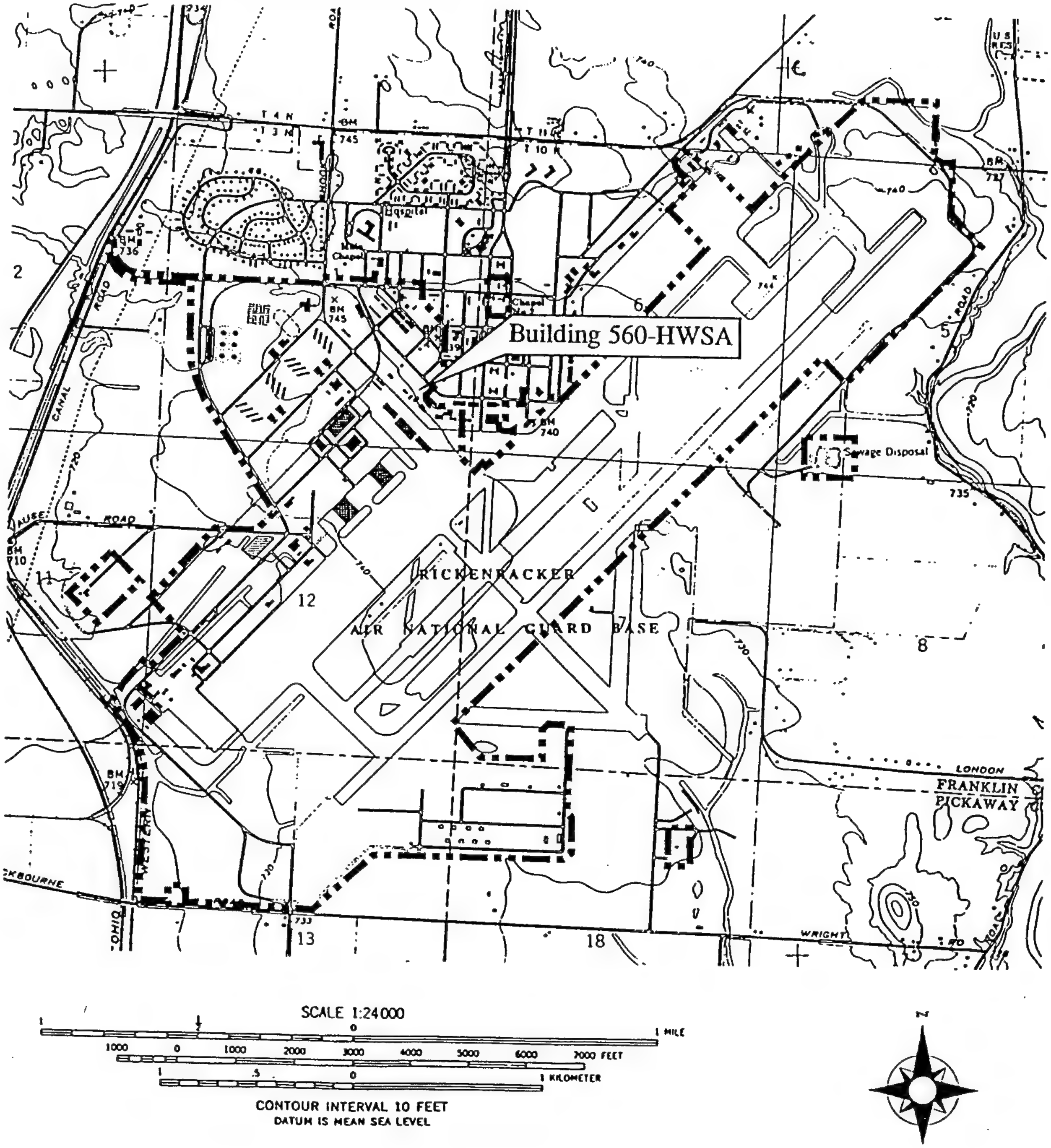


FIGURE 2.2

SITE LOCATION

HWSA
Rickenbacker ANGB, Ohio

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

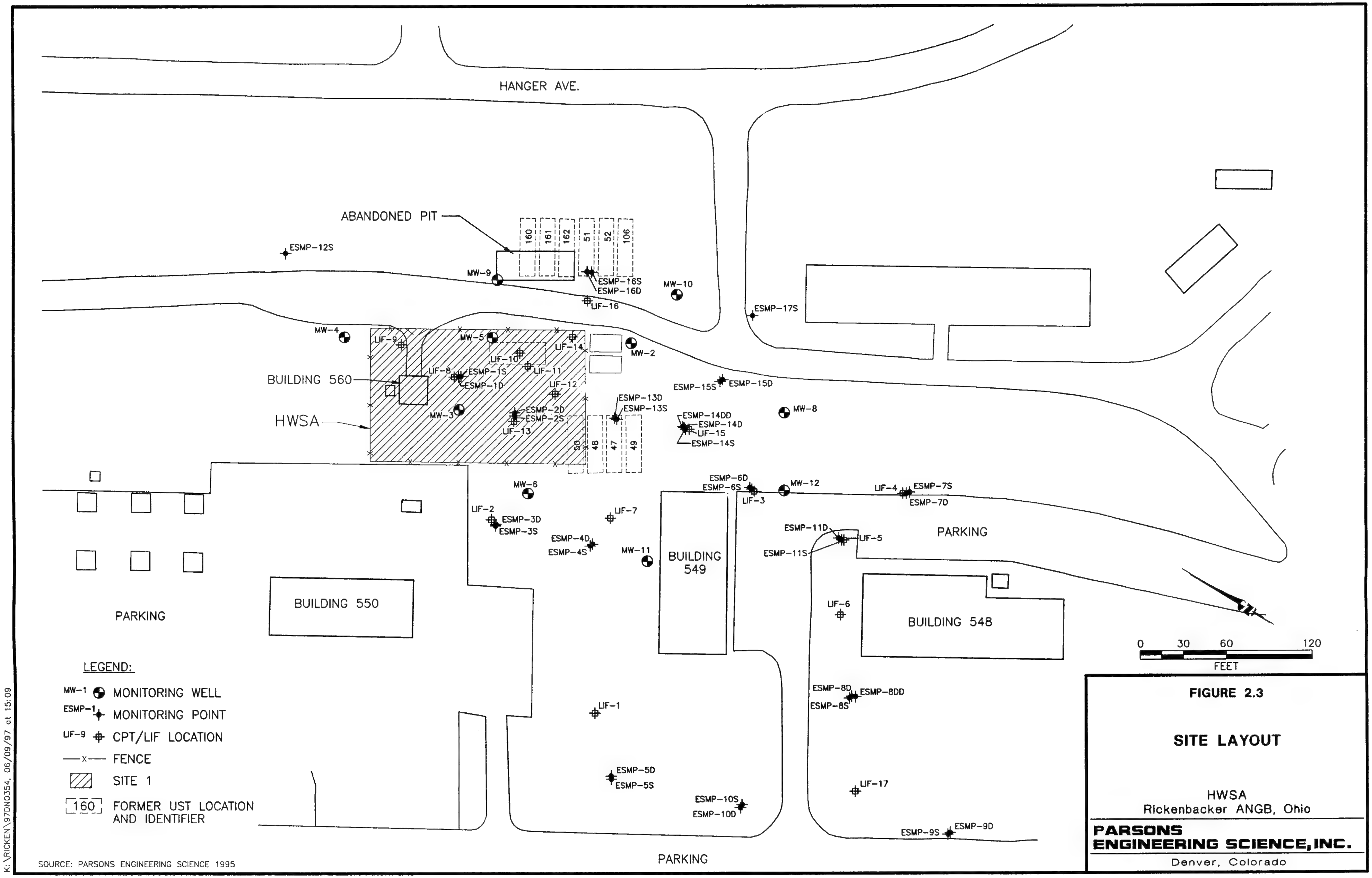


FIGURE 2.3

SITE LAYOUT

HWSA
Rickenbacker ANGB, Ohio

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

The HWSA was a permitted storage facility that received wastes generated during base activities from 1983 to 1986. Hazardous wastes were containerized and brought to the site from other areas of the base. Drum contents were sampled to characterize wastes for disposal or reuse. Wastes were then turned over to the Defense Property Disposal Office (DPDO) for disposal or recycling. The DPDO is now known as the Defense Reutilization and Marketing Office (DRMO).

From 1974 to 1983, Building 560 (see Figure 2.3) housed water demineralization equipment. In 1983, the building was converted to a hazardous waste storage facility. The conversion included sealing off all floor drains that led to storm sewers, connecting remaining drains to the sanitary sewer, and installing emergency eye-wash and shower fixtures. Records indicate Buildings 551 and 552 also were formerly located on this site. Fuel pumping operations were managed from these two buildings. One of the buildings housed the valve controls for fuel hydrants used to off-load fuel from rail cars. Excavations and soil sampling were conducted adjacent to this foundation in 1990. These investigations indicated that the fill material surrounding that structure was not contaminated.

Building 560 consisted of an empty 15' x 15' pre-engineered metal structure and an adjacent 4' x 4' concrete drum wash pad. Building 560 was used to store small (5 gallons or less) containers that usually held acids or spent desiccants. Other materials stored at this site were containerized in 55-gallon drums which were stored outside the building within the fenced area. As many as 165 containers at one time were stored on pallets in the grass area outside Building 560. Table 2.1 summarizes types and quantities of waste that were stored at the site from 1983 until 1986, when the HWSA was closed.

Additionally, five 12,000-gallon USTs (Tanks #53-57) and ten 25,000-gallon USTs (Tanks #47 through #52, #106, #160, #161, and #162) were previously located at or within the vicinity of the site. These USTs were removed in 1994 and 1995. The locations of the ten former 25,000-gallon USTs are shown on Figure 2.3. The five former 12,000-gallon USTs were located approximately 700 feet north-northwest of Building 560. The AFBCA received NFRAP status from the Ohio Department of Commerce, Division of State Fire Marshal, BUSTR in March 1996 for Tanks #51 through #57, #106, #160, #161, and #162. The NFRAP status for Tanks #47 through #50 excluded soil and groundwater and was given for the tanks only. Residual contamination in soils and groundwater for these four tanks are addressed as part of the closure approach presented in the closure/post-closure plan (Parsons ES, 1997). Sections 3 and 4 of this work plan describe the additional assessment activities to be completed in support of implementing the closure approach described in the 1997 closure/post-closure plan.

2.2 PHYSICAL SETTING

2.2.1 Site Topography and Surface Hydrology

The site topography varies from approximately 740 to 742 feet above mean sea level (amsl). The site topography is shown on Figure 2.4. The site slopes to the east. No significant surface water drainages are present at the site.

TABLE 2.1
SUMMARY OF WASTES STORED AT THE HAZARDOUS WASTE STORAGE AREA
HAZARDOUS WASTE STORAGE AREA
AMENDED CLOSURE/POST-CLOSURE PLAN
RICKENBACKER ANGB, OHIO

		Quantity (by year)			
Waste Description	USEPA Haz Waste No.	1983 (gals)	1984 (gals)	1985 (gals)	1986 (lbs)
PD 680 (Stoddard Solvent, Flammable Aliphatic Petroleum Distillate	D001	1,155	1,450	110	2,429
Carbon-Removing Compound (Methylene Chloride, Creosols, Phenols)	F001, F004	590	870	--	--
Highly Aromatic Naptha	D001	500	290	--	--
Methyl Ethyl Ketone	F005	285	525	--	1,050
Paint Remover	F005	200	540	--	--
Bromochloromethane	--	200	385	--	--
Sulfuric Acid	D002	25	25	--	--
Paint Thinner	D001	20	20	--	--
Ethanolamine and Benzyl Alcohol	D001	220	--	--	--
Oily Water and Cleaning Solutions Containing Lead, Cadmium, Chromium, and Nickel	D006, D007, D008	495	--	--	--
Hydraulic Fluid	--	0	360	--	--
Synthetic Oil	--	--	440	--	--
Inspection Penetrant	--	--	150	--	--
Organic Peroxide	D002	--	--	1	--
Spent Desiccant (Cobalt chloride) [a/]	--	50	40	10	--

[a/] Quantities for desiccant for all years are shown in pounds.

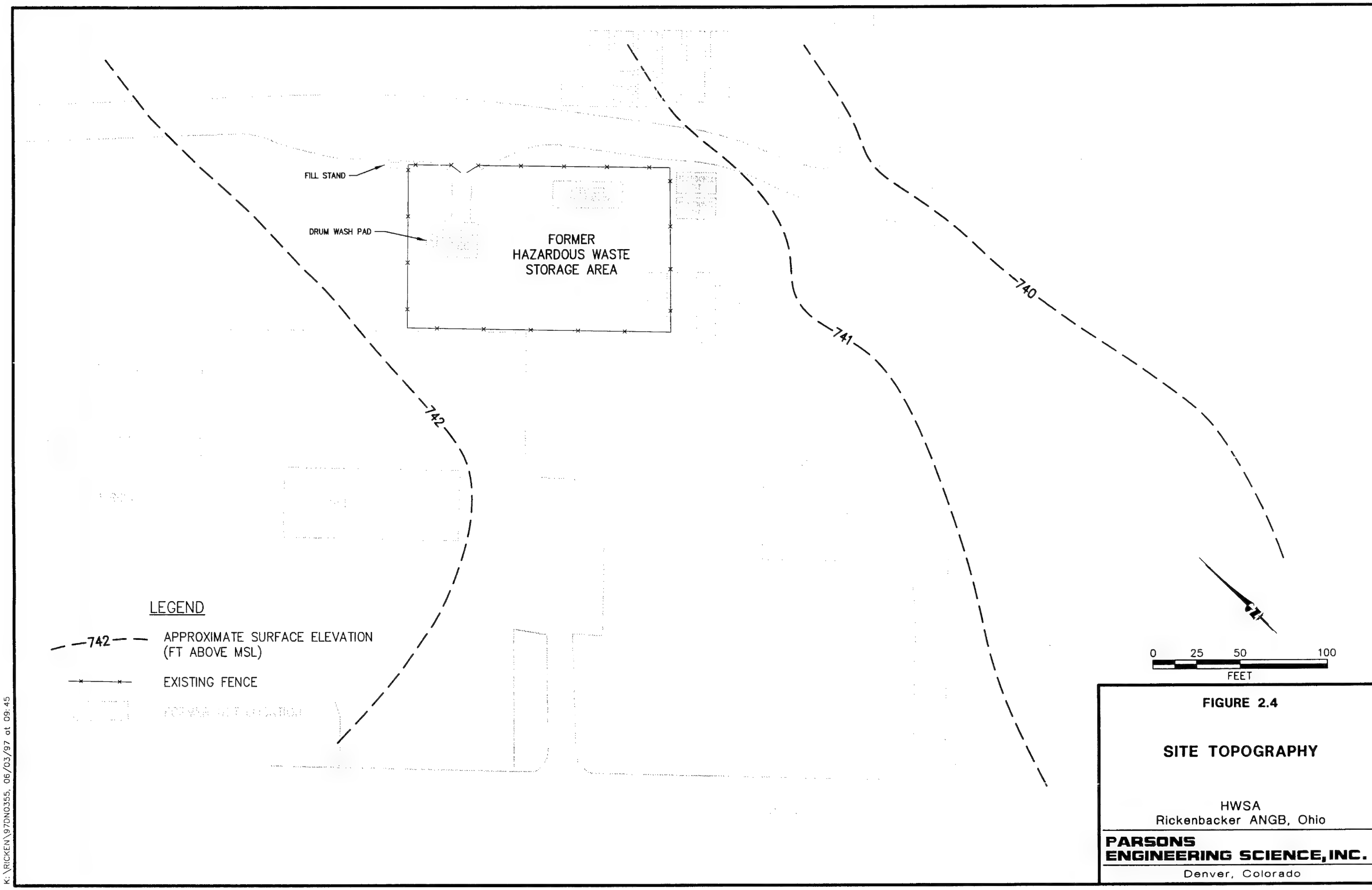


FIGURE 2.4

SITE TOPOGRAPHY

HWSA
Rickenbacker ANGB, Ohio

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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2.2.2 Site Geology and Hydrogeology

Geologic cross sections were prepared for the HWSA using the lithologic descriptions from the soil borings and monitoring well borings and the results of the cone penetrometer testing. The cross section locations are shown in Figure 2.5 and the cross sections are in Figures 2.6 and 2.7.

Lithologic data indicate that the uppermost lithologic unit at the base is a Wisconsin-age ablation till. The ablation till overlays a Wisconsin-age basal till. Brown and gray silt and clay is present at HWSA from the surface to a depth of approximately 10 to 14 feet below ground surface (bgs). Beneath the uppermost silt and clay, sand and gravel deposits are typically encountered in most borings. The sand and gravel deposits appear to be laterally continuous across most of HWSA. The sand and gravel is thickest in the northern and central portions of the site. In the northern portion of the site the sand and gravel is approximately eight feet thick and directly overlays the gray silt and clay basal till. In the central and southern portions of the site, the sand and gravel zones are generally less than five feet thick and are interbedded with silt and clay.

The water level measurements and groundwater elevations from the quarterly sampling at HWSA are presented in Table 2.2. Review of the potentiometric data indicate that there is generally a considerable difference (often more than 2 feet) in the groundwater elevation in adjacent monitoring point pairs. The vertical gradient is downward in most cases. However, upward gradients are sometimes observed in some monitoring point pairs. Therefore, accurate representation of the flow direction and horizontal gradient of the groundwater beneath the site can only be obtained by using monitoring points screened in the same laterally continuous stratigraphic unit. Monitoring points ESMP-1D, 4D, 13S, 14S, and 17S are all screened in a sand zone encountered at a depth of approximately 14 feet bgs. The sand appears to be laterally continuous between these monitoring point locations. The groundwater flow direction is generally east, with a horizontal hydraulic gradient of approximately 5×10^{-4}, or approximately 1 foot change in elevation every 1,800 feet horizontally. Figure 2.8 is the potentiometric surface from the June 1996 sampling event. The potentiometric surface from June 1996 is representative of the groundwater flow direction and gradient noted during other sampling events.

2.3 CHEMICALS WARRANTING FURTHER EVALUATION

It is the intention of the Air Force to obtain approval for a risk assessment-based closure for the HWSA. To accomplish this objective, the Air Force must demonstrate complete removal of waste materials and decontamination of environmental media to health-based standards. In addition, the Air Force must demonstrate that environmental media being left in-place will not pose a significant threat to human health. In anticipation of preparing an amended closure/post-closure plan, or preparing an amendment to the existing plan (Parsons ES, 1997) that specifies health-protective closure or performance goals, the Air Force will be collecting additional environmental samples. As described in this work plan, these samples are required primarily to assess the effectiveness of various natural and engineered remedial technologies at minimizing contaminant mass, mobility, and toxicity in impacted environmental media.

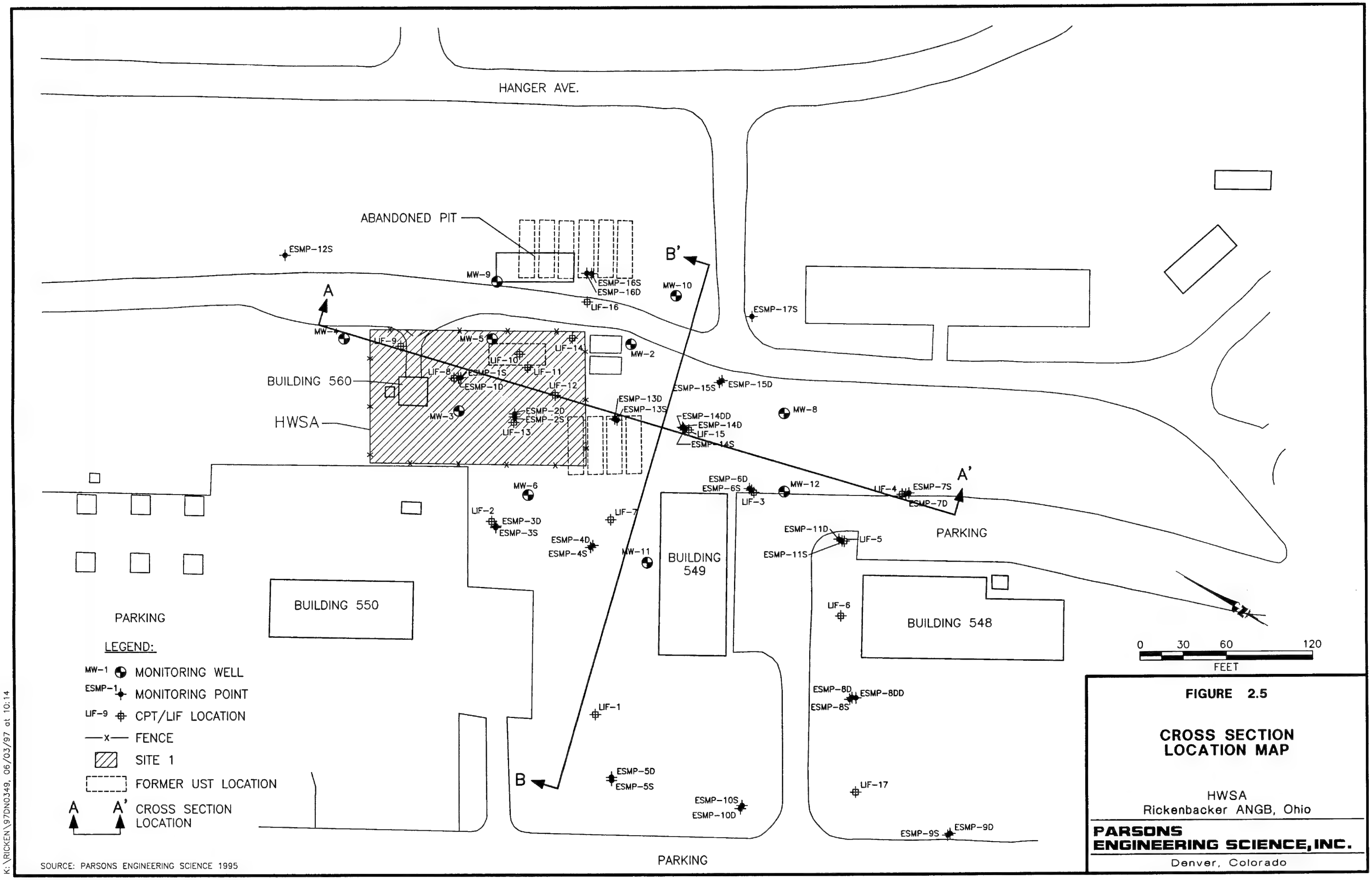
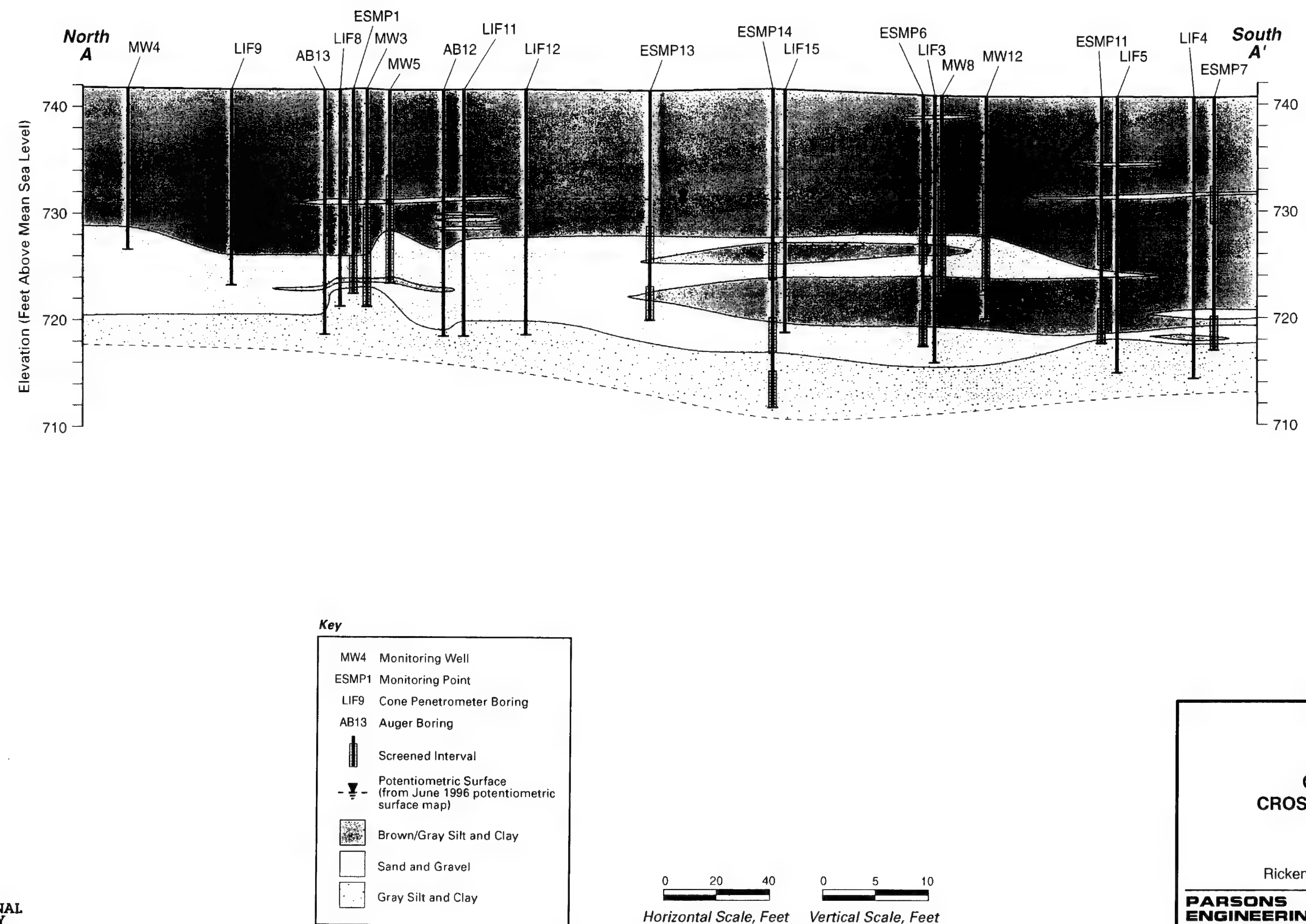


FIGURE 2.5

CROSS SECTION LOCATION MAP

HWSA
Rickenbacker ANGB, Ohio

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado



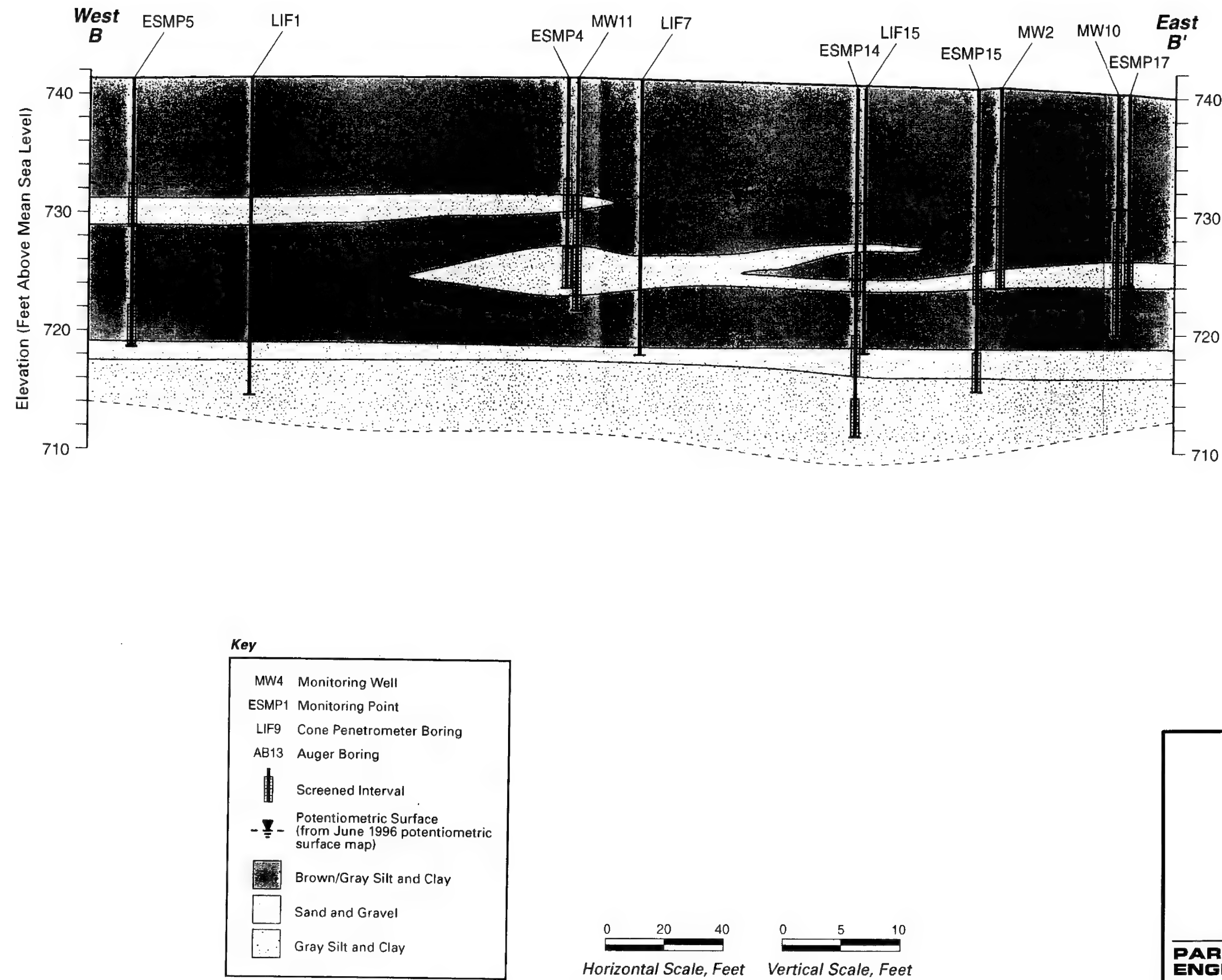
Source:
INTERNATIONAL TECHNOLOGY CORPORATION

FIGURE 2.6

GEOLOGIC CROSS SECTION A-A'

HWSA
Rickenbacker ANGB, Ohio

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado



Source: INTERNATIONAL TECHNOLOGY CORPORATION

FIGURE 2.7

GEOLOGIC
CROSS SECTION B-B'

HWSA
Rickenbacker ANGB, Ohio

PARSONS
ENGINEERING SCIENCE, INC.
Denver, Colorado

Table 2.2
Groundwater Elevation Data
Hazardous Waste Storage Area
Rickenbacker ANGB, Ohio

		8/15/95		12/20/95		3/18/96	
Well ID	Datum Elevation (ft msl)	Depth to Water (ft)	Groundwater Elevation	Depth to Water (ft)	Groundwater Elevation	Depth of Water (ft)	Groundwater Elevation
MW-02	743.36	12.14	731.22	13.23	730.13	11.26	732.10
MW-03	743.96	10.46	733.50	13.05	730.91	8.60	735.36
MW-04	745.15	11.38	733.77	13.26	731.89	9.86	735.29
MW-05	744.97	13.37	731.60				
MW-06	745.18	13.75	731.43	14.96	730.22	13.06	732.12
MW-08	743.89	10.53	733.36	12.94	730.95	8.43	735.46
MW-09	745.25	8.05	737.20	13.55	731.70		
MW-10	742.64	11.23	731.41	12.30	730.34		
MW-11	744.15	12.19	731.96	13.55	730.60	11.64	732.51
MW-12	743.02	13.10	729.92	13.71	729.31	11.98	731.04
ESMP-1S	741.67	7.43	734.24	9.44	732.23	5.65	736.02
ESMP-1D	741.72	10.17	731.55	10.56	731.16	8.87	732.85
ESMP-2S	741.18	3.57	737.61	5.83	735.35	1.73	739.45
ESMP-2D	741.29	6.18	735.11	10.10	731.19	8.55	732.74
ESMP-3S	742.23	7.68	734.55	11.26	730.97	7.82	734.41
ESMP-3D	742.22	10.69	731.53	11.92	730.30	9.94	732.28
ESMP-4S	742.70	5.94	736.76	9.92	732.78	6.92	735.78
ESMP-4D	742.69	11.15	731.54	12.23	730.46	10.42	732.27
ESMP-5S	741.51	3.83	737.68	6.89	734.62	3.46	738.05
ESMP-5D	741.56	6.20	735.36	9.00	732.56	2.07	739.49
ESMP-6S	740.98	10.79	730.19				
ESMP-6D	741.05	9.69	731.36	10.69	730.36	8.87	732.18
ESMP-7S	740.85	6.02	734.83	5.33	735.52	3.69	737.16
ESMP-7D	740.80	5.96	734.84	8.62	732.18	5.57	735.23
ESMP-8S	740.92	3.76	737.16	6.73	734.19	2.87	738.05
ESMP-8D	740.89	6.17	734.72	8.85	732.04		
ESMP-8DD	740.83	7.38	733.45	9.58	731.25	7.07	733.76
ESMP-9S	741.79	3.38	738.41	5.22	736.57	1.46	740.33
ESMP-9D	741.70	6.53	735.17	9.35	732.35	6.27	735.43
ESMP-10S	741.56	6.15	735.41	10.03	731.53	7.26	734.30
ESMP-10D	741.54	6.41	735.13	9.22	732.32	6.28	735.26
ESMP-11S	740.76	6.66	734.10	7.15	733.61	6.42	734.34
ESMP-11D	740.80	7.11	733.69	9.04	731.76	6.69	734.11
ESMP-12S	742.43	2.57	739.86	6.23	736.20	0.40	742.03
ESMP-13S	741.38	10.34	731.04	10.90	730.48	9.34	732.04
ESMP-13D	741.38	10.06	731.32	10.56	730.82	9.10	732.28
ESMP-14S	741.17	10.13	731.04	10.31	730.86	9.16	732.01
ESMP-14D	741.18	9.89	731.29	10.37	730.81	8.92	732.26
ESMP-14DD	741.13	9.72	731.41	10.56	730.57	8.93	732.20
ESMP-15S	740.37	9.45	730.92	9.68	730.69	8.47	731.90
ESMP-15D	740.28	8.98	731.30	9.45	730.83	7.98	732.30
ESMP-16S	740.33	8.00	732.33	9.60	730.73	7.78	732.55
ESMP-16D	740.33	8.77	731.56	9.18	731.15	7.87	732.46
ESMP-17S	739.87	9.19	730.68	9.56	730.31	8.52	731.35

Table 2.2 (Continued)
Groundwater Elevation Data
Hazardous Waste Storage Area
Rickenbacker ANGB, Ohio

	6/25/96		9/23/96		12/2/96	
Well ID	Depth of Water (ft)	Groundwater Elevation	Depth of Water (ft)	Groundwater Elevation	Depth of Water (ft)	Groundwater Elevation
MW-02	12.00	731.36	15.37	727.99	10.63	732.73
MW-03	11.49	732.47	15.47	728.49	10.44	733.52
MW-04	11.81	733.34	16.00	729.15	10.30	734.85
MW-05	13.11	731.86	13.92	731.05		
MW-06	13.70	731.48	17.12	728.06	12.28	732.90
MW-08	11.28	732.61	15.78	728.11	8.36	735.53
MW-09	7.86	737.39				
MW-10	11.06	731.58				
MW-11	12.11	732.04	15.60	728.55	10.95	733.20
MW-12	12.28	730.74	15.07	727.95	10.32	732.70
ESMP-1S	8.28	733.39				
ESMP-1D	10.00	731.72				
ESMP-2S	4.38	736.80				
ESMP-2D	9.64	731.65	10.07	731.22	8.30	732.99
ESMP-3S	8.94	733.29				
ESMP-3D	10.55	731.67	10.96	731.26	9.15	733.07
ESMP-4S	10.62	732.08	11.08	731.62	9.47	733.23
ESMP-4D	10.93	731.76	11.33	731.36	9.52	733.17
ESMP-5S	4.87	736.64				
ESMP-5D	7.10	734.46				
ESMP-6S	11.92	729.06				
ESMP-6D	9.48	731.57	9.86	731.19	8.06	732.99
ESMP-7S	6.60	734.25				
ESMP-7D	6.75	734.05				
ESMP-8S	4.80	736.12	6.80	734.12	4.18	736.74
ESMP-8D	6.78	734.11				
ESMP-8DD	7.84	732.99				
ESMP-9S	5.14	736.65				
ESMP-9D	7.36	734.34				
ESMP-10S	8.00	733.56	9.96	731.60	8.29	733.27
ESMP-10D	7.22	734.32				
ESMP-11S	7.06	733.70				
ESMP-11D	7.52	733.28				
ESMP-12S	4.21	738.22				
ESMP-13S	10.04	731.34	10.36	731.02	8.64	732.74
ESMP-13D	9.90	731.48				
ESMP-14S	9.84	731.33				
ESMP-14D	9.66	731.52	10.13	731.05	8.29	732.89
ESMP-14DD	9.42	731.71				
ESMP-15S	9.25	731.12				
ESMP-15D	8.80	731.48				
ESMP-16S	8.36	731.97	9.11	731.22	7.18	733.15
ESMP-16D	8.62	731.71	9.07	731.26	7.27	733.06
ESMP-17S	9.19	730.68	9.41	730.46	7.87	732.00

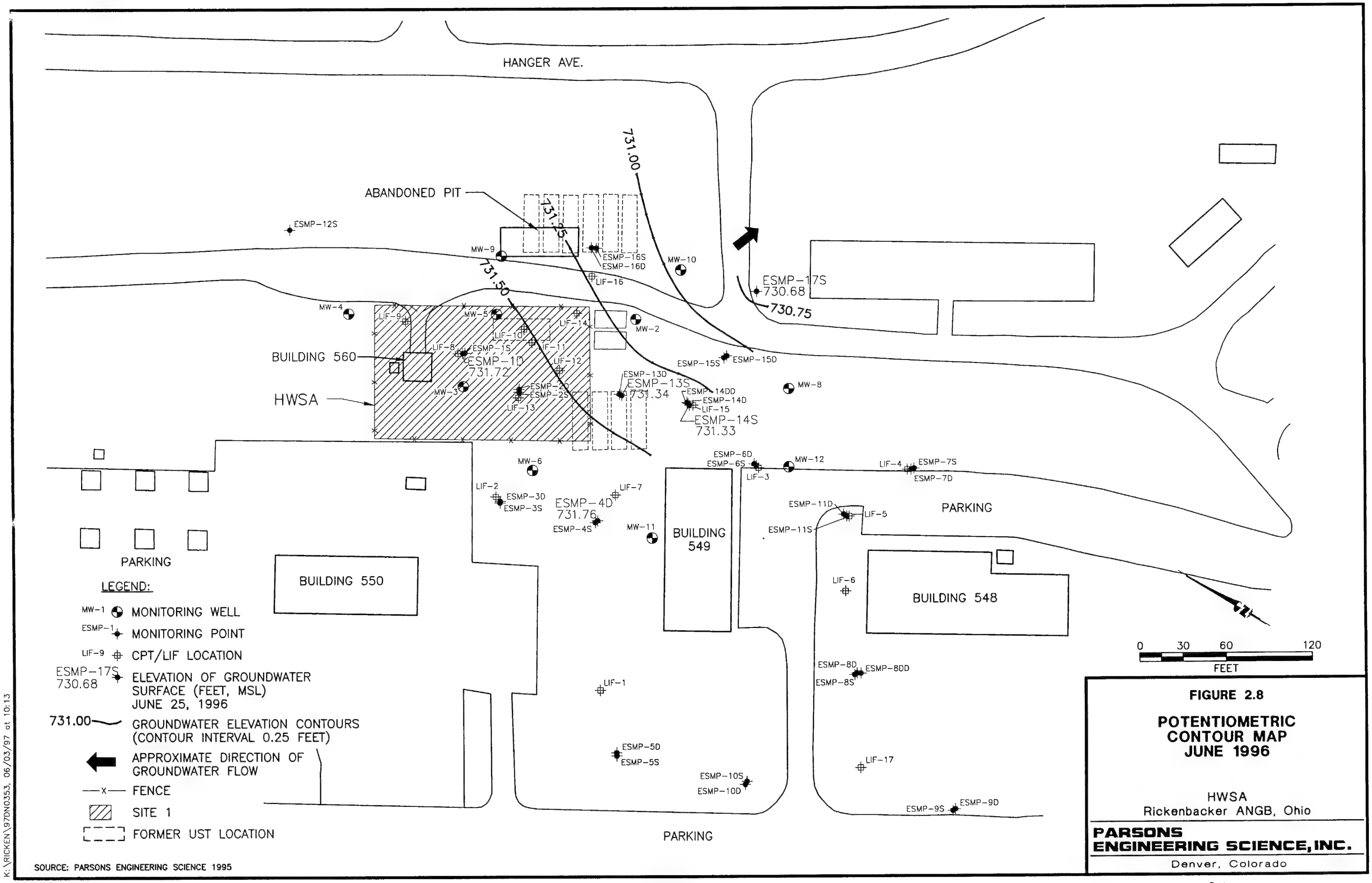


FIGURE 2.8

POTENTIOMETRIC CONTOUR MAP JUNE 1996

HWSA
Rickenbacker ANGB, Ohio

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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These additional sampling results also can be used to support a human health risk assessment. To avoid costly and unnecessary sampling analytical requirements, the Air Force determined that it was important to define the required analyses for the environmental samples to be collected by comparing known site concentrations to conservative, health-protective criteria. These health-protective criteria account for the presence of multiple constituents and the potential for multiple routes of exposure (i.e., inhalation, ingestion, and dermal contact). The objective of this comparison, at this stage in project planning, is to focus additional sampling efforts on those chemicals that are likely to contribute significantly to cumulative site risks. As required by Ohio EPA, the human health risk assessment, which will be prepared to establish final closure requirements at this site, will consider all chemicals detected in the environmental media above appropriate background concentrations. No chemical will be eliminated from this quantitative evaluation as a result of this early comparison.

Analytical data collected during previous Air Force Installation Restoration Program (IRP) site investigations and ongoing monitoring events identified metals, fuel-related hydrocarbons, such as benzene, toluene, ethylbenzene, and xylene (BTEX), and chlorinated aliphatic hydrocarbons (CAHs), such as trichloroethene (TCE) and vinyl chloride, as site-related contaminants in soil and groundwater at the HWSA site. Petroleum hydrocarbon releases from former USTs may have resulted in contamination of the subsurface with mobile and residual light nonaqueous phase liquid (LNAPL). Although all of the USTs and associated piping have been removed, residual contamination in soil and groundwater, especially in the vicinity of former USTs #47 through #50 (Figure 2.3), was left in place.

2.3.1 Development of Appropriate Comparison Criteria

Background concentrations for inorganic compounds in both soil and groundwater have been collected and statistically analyzed for Rickenbacker ANGB during previous IRP efforts. Background locations were selected and approved by the Base Closure Team (BCT) consisting of the Air Force, USEPA, and Ohio EPA (IT Corporation, 1997). The maximum detected concentration for each inorganic was compared to the 95-percent upper confidence limit (UCL) of the mean values from the background sampling set (IT Corporation, 1997). If the maximum detected site concentration was below this estimator of background concentration, no further evaluation was necessary (i.e., the inorganic constituent was shown to be present onsite at concentrations below background or below "clean closure" standards).

After determining which inorganic chemicals were present above background concentrations, all organics and remaining inorganics were compared to conservative, health-based screening criteria. These health-based screening criteria or preliminary remediation goals (PRGs) were developed using the algorithms defined by Ohio EPA (1993b) for both unrestricted land-use and industrial land-use scenarios. These PRGs account for the additive effects of three primary routes of exposure (i.e., inhalation, ingestion, and dermal contact) and the presence of multiple carcinogens and noncarcinogens. The cumulative target risk level for the multi-pathway, multi-chemical PRGs is 10^{-5}. Use of these PRGs does not imply that these exposure assumptions are representative of site conditions; rather, this conservative approach has been adopted only as a means to identify those chemicals that may contribute significantly to cumulative site risks.

Final remedial/closure requirements will be determined after completion of a quantitative human health risk assessment that is based on a site-specific conceptual site model (CSM). Note that the ultimate remedial/closure goal for the HWSA is to restore the site to a status suitable for commercial/industrial use as a taxiway, which is the planned near-term use of the site. Therefore, these PRGs are based on generic exposure assumptions that are more conservative than those representative of a commercial/industrial land-use scenario (see Section 3).

The PRGs for the unrestricted land-use assumption have been weighted to include both child and adult ingestion of soil. Exposure via dermal contact has been conservatively assumed to effect only adult receptors throughout the exposure duration (i.e., more skin surface area and longer daily exposure time). Finally, inhalation of both volatiles and particulates in outdoor environments has been incorporated into the PRGs using the algorithms specified in recent USEPA (1996a) guidance.

Current Ohio EPA guidance (1993b) does not specify whether, or how, to consider leaching of contaminants from soil into underlying groundwater. The Air Force intends to quantitatively explore this potential contaminant release mechanism in more detail as part of the additional assessment activities. Final remedial/closure requirements will reflect the need to protect underlying groundwater quality.

2.3.2 Identification of COPCs in Soils and Groundwater

The analytical requirements for the environmental samples to be collected as part of the proposed additional assessment activities will be based on a comparison of measured site concentrations to both unrestricted and industrial land-use PRGs. Tables 2.3 and 2.4 compare the most recently detected maximum site concentrations for each compound to the appropriate matrix- and/or receptor-specific PRGs. Exceedances are shaded on the tables. For Table 2.3, the maximum soil concentration values were determined based on existing soil data and sample intervals in the vadose zone. Soil sample results from below the water table (i.e., greater than 12 feet bgs) were not included.

Based on comparisons of the maximum detected site chemical concentrations to the conservative PRGs (see Table 2.3), the following compounds are identified as residual soil contaminants warranting further evaluation:

Arsenic	Benzo(b)fluoranthene
Beryllium	Benzo(k)fluoranthene
Thallium	Chrysene
Benzo(a)pyrene	Dibenz(a,h)anthracene
Benazo(a)anthracene	Indeno(1,2,3-cd)pyrene
Benzene	Trichloroethene

Based on a comparison of the maximum chemical concentrations detected in site groundwater to the conservative, health-protective groundwater PRGs (see Table 2.4), the following compounds are identified as residual groundwater contaminants warranting further evaluation:

TABLE 2.3
COMPARISON OF SITE SOIL CONTAMINANT CONCENTRATIONS TO SCREENING CRITERIA
HAZARDOUS WASTE STORAGE AREA
RICKENBACKER ANGB, OHIO

Detected Analytes	Maximum Detected Site Concentration (mg/kg)[a/]	Background[b/] Concentrations (mg/kg)	Max. Conc. Exceeds Background	Preliminary Remediation Goals[c/] Unrestricted Land Use (mg/kg)	Preliminary Remediation Goals[c/] Industrial Land Use (mg/kg)	Max. Conc. Exceeds PRG(s)[d/]
Inorganics						
Antimony	6 N[e/]J[f/]	3.7	Yes	8.3	NA[g/]	No
Arsenic	42 N	15.3	Yes	0.18	1.0	Yes
Beryllium	1.8 NJ	0.89	Yes	0.0082	0.015	Yes
Cadmium	9.1	0.64	Yes	34.4	345	No
Chromium	28.6 J	18.8	Yes	157	265	No
Cobalt	8.9	14.8	No			
Copper	73.1	29.3	Yes	2,990	53,000	No
Lead	382	22.0	Yes	400[h/]	400[h/]	No
Mercury	2.6	0.05	Yes	6.2	14.2	No
Nickel	60	40.3	Yes	929	3,570	No
Selenium	1.7 NJ	0.36	Yes	380	7,830	No
Silver	7.2	0.95	Yes	344	3,450	No
Thallium	10.5	0.56	Yes	6.0	130	Yes
Zinc	522 J	92.1	Yes	21,200	242,000	No
Organics						
Acenaphthene	0.17 J	NA	NA	1,540	3,750	No
Acetone	0.25 D[i/]	NA	NA	6,000	36,800	No
Anthracene	2.2 J	NA	NA	7,700	18,700	No
Benzo(a)pyrene	15	NA	NA	0.0063	0.012	Yes
Benzo(a)anthracene	15	NA	NA	0.063	0.12	Yes
Benzene	15	NA	NA	0.43	0.74	Yes
Benzo(b)fluoranthene	14	NA	NA	0.063	0.12	Yes
Benzo(g,h,i)perylene	8.6	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	20	NA	NA	0.63	1.2	Yes

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TABLE 2.3 (Continued)
COMPARISON OF SITE SOIL CONTAMINANT CONCENTRATIONS TO SCREENING CRITERIA
HAZARDOUS WASTE STORAGE AREA
RICKENBACKER ANGB, OHIO

Detected Analytes	Maximum Detected Site Concentration (mg/kg)[a/]	Background[b/] Concentrations (mg/kg)	Max. Conc. Exceeds Background	Preliminary Remediation Goals [c/] Unrestricted Land Use (mg/kg)	Preliminary Remediation Goals [c/] Industrial Land Use (mg/kg)	Max. Conc. Exceeds PRG(s)[d/]
Organics (continued)						
Bis(2-ethylhexyl)phthalate	4.1	NA	NA	9.2	23	No
Bis(2-Chloroethyl)ether	0.008 J	NA	NA	0.17	0.545	No
2-Chlorophenol	0.008 J	NA	NA	165	463	No
Chrysene	17	NA	NA	15.2	35	Yes
Dibenz(a,h)anthracene	3.5	NA	NA	0.0063	0.012	Yes
Di-n-Butylphthalate	6.5	NA	NA	6,000	36,800	No
cis-1,2-Dichloroethene	5.8	NA	NA	600	3,680	No
trans-1,2,-Dichloroethene	0.57	NA	NA	1,200	7,360	No
Ethylbenzene	120	NA	NA	2,420	5,740	No
Fluoranthene	23	NA	NA	1,030	2,500	No
Fluorene	1.4	NA	NA	1,320	3,700	No
Indeno(1,2,3-cd)pyrene	10	NA	NA	0.063	0.12	Yes
Methylene Chloride	0.13 B	NA	NA	5.44	10	No
Methyl Ethyl Ketone	0.15	NA	NA	32,200	155,000	No
2-Methylnaphthalene	23	NA	NA	NA	NA	NA
Naphthalene	5.4	NA	NA	1,030	2,500	No
3-Nitroaniline	0.024 J	NA	NA	77	187	No
4-Nitroaniline	0.03 J	NA	NA	77	187	No
Phenanthrene	11	NA	NA	NA	NA	NA
Pyrene	25	NA	NA	770	1,870	No
1,1,2,2-Tetrachloroethane	0.0063	NA	NA	0.229	0.43	No
1,1,1-Trichloroethane	0.086 J	NA	NA	NA	NA	No
Trichloroethene	2.6	NA	NA	1.84	3.2	Yes
1,2,4-Trimethylbenzene	0.0248	NA	NA	NA	NA	NA
Vinyl Chloride	0.0013	NA	NA	0.013	0.0233	No

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TABLE 2.3 (Continued)
COMPARISON OF SITE SOIL CONTAMINANT CONCENTRATIONS TO SCREENING CRITERIA
HAZARDOUS WASTE STORAGE AREA
RICKENBACKER ANGB, OHIO

Detected Analytes	Maximum Detected Site Concentration (mg/kg)[a/]	Background[b/] Concentrations (mg/kg)	Max. Conc. Exceeds Background	Preliminary Remediation Goals [c/] Unrestricted Land Use (mg/kg)	Industrial Land Use (mg/kg)	Max. Conc. Exceeds PRG(s)[d/]
Organics (continued)						
m/p-Xylene	15	NA	NA	120,000	736,000	No
o-Xylene	1,900	NA	NA	120,000	736,000	No

Note: Supporting calculations for this table are available upon request from Parsons ES.

[a/] mg/kg = milligrams per kilogram.

[b/] Source: (IT, 1997). Background concentrations represent the 95 percent upper confidence limit (UCL) of the arithmetic mean for surface soil samples (samples collected from 1 to 2 feet below ground surface).

[c/] Preliminary Remediation Goals (PRGs) calculated based on dose equation and standard default parameters from Ohio EPA (1993b). The value shown represents the most conservative PRG when considering the carcinogenic and noncarcinogenic calculated values.

[d/] "Yes" is shown if the maximum detected site concentration exceeds one or more of the preliminary remediation goals shown.

[e/] N = spiked sample recovery not within control limits.

[f/] J = compound detected, but below the laboratory reporting limit; value shown represents a laboratory estimated concentration.

[g/] NA = not applicable.

[h/] A screening level of 400 mg/kg has been set for lead based on *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities* (USEPA, 1994).

[i/] D = result is calculated from a greater dilution than the primary analysis.

TABLE 2.4
COMPARISON OF SITE GROUNDWATER CONTAMINANT CONCENTRATIONS TO SCREENING CRITERIA
HAZARDOUS WASTE STORAGE AREA
RICKENBACKER ANGB, OHIO

Detected Analytes	Maximum Detected Site Concentration (mg/L)[a]	Background[b] Concentration (mg/L)	Max. Conc. Exceeds Background	Preliminary Remediation Goals[c] Unrestricted Land Use (mg/L)	Industrial Land Use (mg/L)	Max. Conc. Exceeds PRG(s)
Inorganics						
Aluminum	0.3	5.5	No			
Antimony, NF[d]	0.0654 J[e]	ND[f]	Yes	0.0146	0.0245	Yes
Arsenic, NF	0.0589 J	0.0069	Yes	0.000056	0.000095	Yes
Arsenic, F[g]	0.0121	0.0069	Yes	0.000056	0.000095	Yes
Barium	0.11	0.109	Yes	2.56	4.29	No
Beryllium, NF	0.0121	ND	Yes	0.000019	0.000033	Yes
Cadmium, NF	0.006	ND	Yes	0.0183	0.0307	No
Calcium, NF	120	170	No			
Chromium (total), NF	0.0965	ND	Yes	0.183	0.307	No
Copper, NF	0.868	ND	Yes	1.46	2.45	No
Copper, F	0.0062 J	ND	Yes	1.46	2.45	No
Iron	0.64	363	No			
Lead, NF	0.195	ND	Yes	0.015[h]	0.015[h]	Yes
Lead, F	0.0077 S[i]J	ND	Yes	0.015[h]	0.015[h]	No
Magnesium	44	69.4	No			
Manganese	1.6	1.34	Yes	1.83	3.07	No
Mercury, NF	0.00055	0.0001	Yes	0.011	0.018	No
Mercury, F	0.00011 J	0.0001	Yes	0.011	0.018	No
Nickel, NF	0.169	ND	Yes	0.73	1.23	No
Potassium	0.91	0.514	Yes			No[j]
Selenium, NF	0.013 JW[k]	ND	Yes	0.183	0.307	No
Silver, NF	0.009	0.0067	Yes	0.183	0.307	No
Sodium	6.8	11.2	No			
Thallium, NF	0.004	ND	Yes	0.0029	0.0049	Yes
Zinc, NF	3.26	0.034	Yes	11	18.4	No
Zinc, F	0.021 J	0.034	No	11	18.4	No

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TABLE 2.4 (continued)
COMPARISON OF SITE GROUNDWATER CONTAMINANT CONCENTRATIONS TO SCREENING CRITERIA
HAZARDOUS WASTE STORAGE AREA
RICKENBACKER ANGB, OHIO

Detected Analytes	Maximum Detected Site Concentration (mg/L)[a/]	Background[b/] Concentration (mg/L)	Max. Conc. Exceeds Background	Preliminary Remediation Goals [c/] Unrestricted Land Use (mg/L)	Industrial Land Use (mg/L)	Max. Conc. Exceeds PRG(s)
Organics						
1,1,2,2-Tetrachloroethane	0.005 J	NA[l/]	NA	0.00038	0.00068	Yes
1,1-Dichloroethene	0.0023 J	NA	NA	0.00012	0.00021	Yes
1,2-Dichloroethane	0.220	NA	NA	0.00088	0.0015	Yes
cis-1,2-Dichloroethene	1.5 E[m/]	NA	NA	0.365	0.613	Yes
trans-1,2-Dichloroethene	0.048	NA	NA	0.73	1.23	No
2-Butanone	0.0023 J	NA	NA	21.9	36.8	No
2-Hexanone	0.0021 J	NA	NA	NA	NA	NA
4-Methyl-2-pentanone	0.0019 J	NA	NA	2.92	4.91	No
2-Methylnaphthalene	0.083 D[n/]	NA	NA	NA	NA	NA
bis(2-ethylhexyl)phthalate	0.16 D	NA	NA	0.006	0.0102	Yes
Acetone	2.4 D	NA	NA	3.65	6.13	No
Benzene	0.51	NA	NA	0.0024	0.0044	Yes
Chloromethane	0.003 J	NA	NA	0.0062	0.0108	No
Ethylbenzene	0.23	NA	NA	1.95	4.27	No
Methylene chloride	0.037 B[o/]JD	NA	NA	0.0109	0.0186	Yes
Naphthalene	0.006 J	NA	NA	0.328	0.9	No
Toluene	0.025 J	NA	NA	4.87	9.81	No
Trichloroethene	0.13	NA	NA	0.0077	0.013	Yes
Vinyl Chloride	0.21 D	NA	NA	0.000041	0.000072	Yes
m,p-Xylene	0.25	NA	NA	NA	NA	NA
o-Xylene	0.086	NA	NA	NA	NA	NA
Xylene (total)	0.29	NA	NA	38.6	84.9	No

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TABLE 2.4 (continued)
COMPARISON OF SITE GROUNDWATER CONTAMINANT CONCENTRATIONS TO SCREENING CRITERIA
HAZARDOUS WASTE STORAGE AREA
RICKENBACKER ANGB, OHIO

Note: Supporting calculations for this table are available upon request from Parsons ES.

a/ mg/L = milligrams per liter.

b/ Source: (IT, 1997). Background concentrations represent the 95 percent upper confidence limit (UCL) of the logarithmic mean for groundwater samples.

c/ Preliminary remediation goals (PRGs) calculated based on dose equation and standard default parameters from Ohio EPA (1993b).

d/ NF = groundwater samples which were not filtered upon field collection.

e/ J = value shown represents a laboratory estimate; analyte was detected, but below the laboratory reporting limit.

f/ ND = not detected.

g/ F = groundwater samples which were filtered upon field collection.

h/ Value shown represents a federal action level for drinking water.

i/ S = reported value was determined by the Method of Standard Additions (MSA).

j/ Although this compound exceeds its background concentration, it is an essential human nutrient and is not identified as a COPC.

k/ W = post digestion spike for furnace atomic absorption analysis is out of control limits (85-115%), while sample absorbance is less than 50% of spike absorbance.

l/ NA = not applicable.

m/ E = concentraion exceeded upper calibration standard.

n/ D = compound identified in an analysis at a secondary dilution factor.

o/ B = analyte found in associated blank as well as in sample.

Antimony	1,2-Dichloroethane
Arsenic	*cis*-1,2-Dichloroethene
Beryllium	bis(2-ethylhexyl)Phthalate
Lead	Benzene
Thallium	Methylene Chloride
1,1,2,2-Tetrachloroethane	Trichloroethene
1,1-Dichloroethene	Vinyl Chloride

Consequently, any additional analytical data for these compounds that can be collected during the proposed assessment activities will enhance the Air Force's ability to identify and implement the most cost-effective and health-protective closure strategy at the HWSA. These data will supplement those collected under earlier sampling efforts. However, more recent data on these specific chemicals will provide the Air Force and Ohio EPA with a better understanding of the current nature and extent of potential chemical site risks. The following section presents recent site sampling data on the chemicals warranting further evaluation.

2.4 NATURE AND EXTENT OF COPCS IN SITE MEDIA

This section briefly summarizes the nature and extent of COPCs in site soils and groundwater. Emphasis is given to describing the extent of volatile organic compound (VOC) contamination, particularly in groundwater, as these compounds are more mobile than the other COPCs (i.e., metals and semi-volatile organic compounds [SVOCs]). Rather than provide an exhaustive description of analytical results for all COPCs, this work plan focuses on bounding the maximum extent of site-related contamination.

2.4.1 Soil Gas Survey

A ten-point soil gas survey for benzene, toluene, and o-xylene was conducted at HWSA in 1988. *O*-xylene was detected in two of the ten sampling locations, SG-1 and SG-6 at 29.8 parts per million, volume per volume (ppmv) and 0.07 ppmv, respectively. Benzene and toluene were detected at only one location, SG-6, at concentrations of 0.49 ppmv and 0.10 ppmv, respectively. All soil gas samples were collected from 5 feet bgs, except for SG-8, which was collected from 3.5 feet bgs. Soil gas sample locations are shown on Figure 2.9. The results of the soil gas survey are presented in the site investigation report (ES, 1989).

2.4.2 Soil Data

The most recent soil samples primarily have been collected at the HWSA during early investigations (June 1988 through October 1991). These soil samples were generally analyzed for VOCs, SVOCs, and metals, although not all soil samples were analyzed for all parameters. The surface soil samples collected from the sampling grid (designated "SU" and "SS") were analyzed for SVOCs and metals. The auger boring

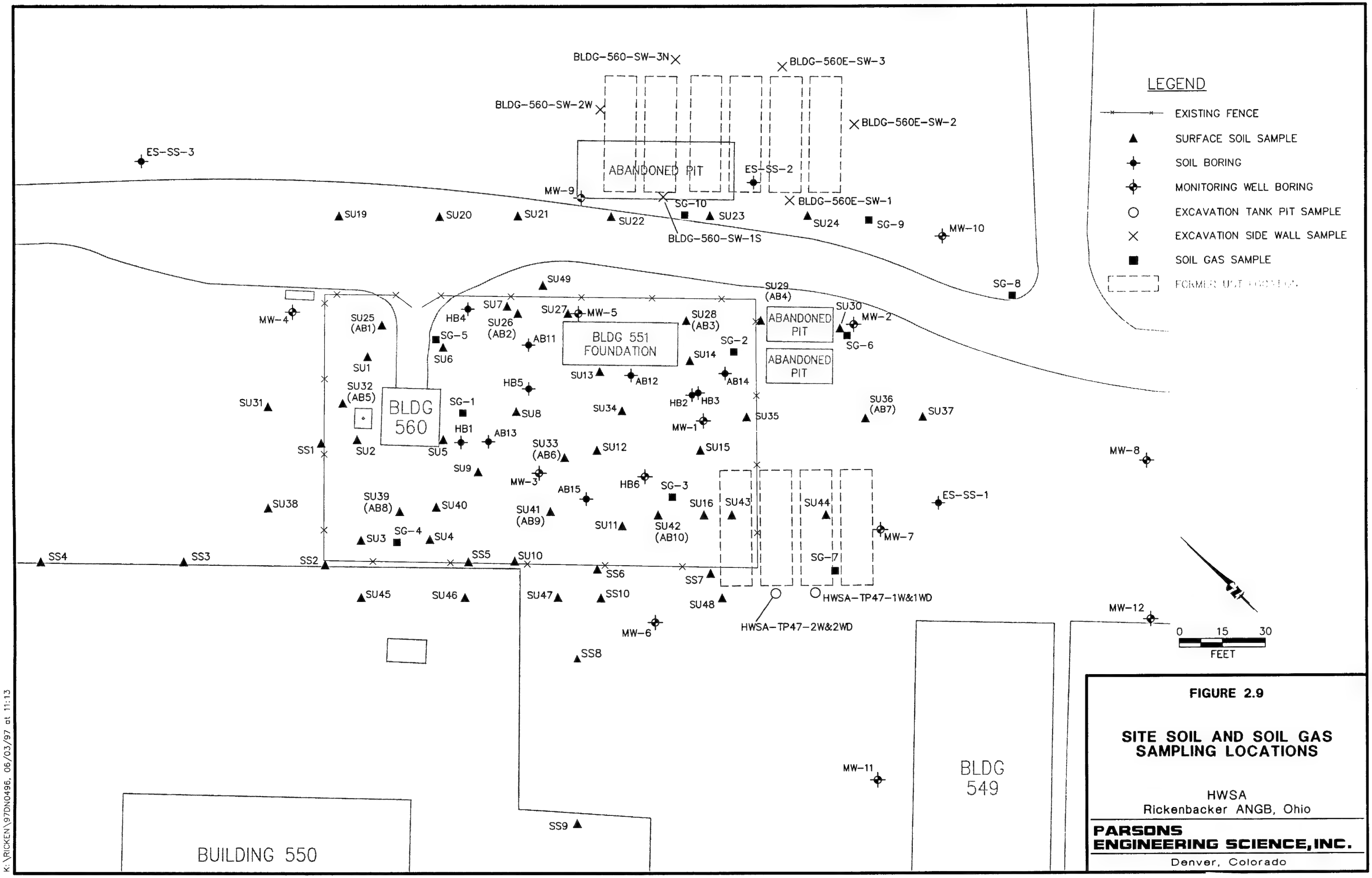

FIGURE 2.9

SITE SOIL AND SOIL GAS SAMPLING LOCATIONS

HWSA
Rickenbacker ANGB, Ohio

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

samples, hand boring samples, and the soil samples from monitoring well borings (designated "AB", "HB", and "MW") were analyzed for VOCs, SVOCs, and metals. The analytical results were presented on Sheets 1 through 5 in the 1997 closure/post-closure plan (Parsons ES, 1997) and the sample locations are shown on Figure 2.9. Soil VOC results are summarized in Table 2.5. Soil results for the COPC VOCs are presented in the following sections according to 5 depth intervals: 0 to 2 feet, 3 to 5 feet, 8 to 10 feet, 13 to 15 feet, and greater than 15 feet. In addition, soil results for metals and SVOCs which appear to be elevated based on background concentration and screening comparison criteria (Table 2.3) also are briefly discussed. Soil data also was obtained using a cone penetrometer (CPT) rig equipped with laser induced fluorescence (LIF) equipment. LIF can indicate the presence of hydrocarbons in the soil.

2.4.2.1 Depth Interval 0 to 2 feet

The only surface soil samples analyzed for VOCs were from borings HB-1 through HB-6 and MW-2. The only COPC VOCs detected were o-xylene in HB-1 at 440,000 micrograms per kilogram (μg/kg), o-xylene in HB-2 at 43 μg/kg, and methylene chloride in the sample from MW-2 at 5 μg/kg.

Sixty-one surface soil samples (0 to 2 feet bgs) were collected at the HWSA and analyzed for metals since June 1988. Based on these sample results, cadmium is the metal most often detected at concentrations at, or greater than, background (Table 2.3). Results from twenty-four surface soil samples indicate cadmium concentrations greater than 0.64 milligram per kilogram (mg/kg) and the maximum cadmium concentration (9.1 mg/kg) was detected from a composite soil sample at SU-9 and SU-10 (Figure 2.9). Cadmium concentrations appear to be greatest in soil samples collected in the southwestern two thirds of the site (SU-5 through SU-16 and HB-1 and HB-2). Chromium is the second metal at the HWSA most frequently detected at, or greater than, background. Chromium was detected in ten samples at concentrations greater than background (18.8 mg/kg) with a maximum concentration of 25.6 mg/kg (SU-5 and SU-6 composite sample). Other metals detected above background in 0- to 2-foot depth intervals include arsenic (42 mg/kg at HB-4), beryllium (1.8 mg/kg at SU-20) and silver (7.2 mg/kg at SU-26. 3 mg/kg at SS-1, and 1.8 mg/kg at SU-46).

Several SVOCs were detected in surface soil samples collected at the HWSA. Based on the comparison criteria presented in Table 2.3, benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene are the four SVOCs most frequently detected at concentrations potentially significant to site receptors. Soil sample results from SU-5, SU-6, SU-19, SU-22, SU-26, SU-30, SU-33, SU-38, SU-45, and SU-46 all exceed comparison criteria for these four compounds. The most significant SVOC contamination appears to be at the western corner of the site, outside the fence, near SU-45 and SU-46 and on the southern side of Building 560 and its driveway, near SU-5 and SU-6 (see Table 2.3 and Figure 2.9).

Benzo(k)fluoranthene, chrysene, and dibenz(a,h)anthracene were also detected at elevated concentrations at some of these locations. Naphthalene has been detected at 5,400 μg/kg from the soil sample collected at HB2.

Table 2.5
Volatile Organic Chemicals Detected in Soil Samples
Rickenbacker ANGB

Location	Date	VOC	0 - 2	3 - 5	8 - 10	13 - 15	14 - 16	15 - 17	17 - 19	21 - 23	25 - 27
			Sample Interval in Feet Below Ground Surface								
HB-1	Jul-88	Ethylbenzene	--	120,000							
		0-xylene	440,000	1,900,000							
HB-2	Jul-88	o-xylene	43	--							
HB-2+HB-3	Jul-88		--								
HB-4	Jul-88		--	--							
HB-5	Jul-88		--								
HB-6	Jul-88		--	--							
AB-1	Jan-90	Ethylbenzene		--	6,700						
		m/p-xylene		--	6,000						
		o-xylene		--	12,000						
AB-2	Jan-90	Benzene		1J	--						
AB-3	Jan-90	Benzene		--	39						
AB-4		Acetone		--	250D						
		Ethylbenzene		--	20						
		m/p-xylene		--	36						
		o-xylene		--	51						
AB-5	Jan-90			--	--						
AB-6	Jan-90	Benzene		--	1J						
AB-7	Jan-90	Methylene chloride		130B	--						
AB-8	Jan-90			--	--						
AB-9	Jan-90			--	--						
AB-10	Jan-90			--	--						
AB-11	Jan-90							--			
AB-12	Jan-90									--	
AB-13	Jan-90								--	--	
AB-14	Jan-90	Benzene			15,000					6	
		Ethylbenzene			15,000					--	
		m/p-Xylene			15,000					--	
		o-Xylene			27,000					--	

Table 2.5 (Continued)
Volatile Organic Chemicals Detected in Soil Samples
Rickenbacker ANGB

			Sample Interval in Feet Below Ground Surface					
AB-15	Jan-90	Acetone				640		--
		Trichloroethene				--		4J
		Ethylbenzene				250		--
MW-1	Jul-88	Benzene				--	1,900	
		Ethylbenzene				1,700	11,000	
		o-Xylene				1,600	20,000	
MW-2	Jul-88	Methylene chloride	5	5				
MW-3	Aug-88		--		--			
MW-4	Jan-90					--		
MW-5		Ethylbenzene			--	7,400		
		m/p-Xylene			--	1,900		
		o-Xylene			--	7,000		
MW-6	Jan-90	Vinyl Chloride			--	59		
		1,1-Dichloroethene			--	2J		
		trans-1,2-Dichloroethene			--	1000D		
		Trichloroethene			--	40		
		Toluene			--	1J		
MW-7	Jan-90	1,1,1-Trichloroethane			86J	--		
		Benzene			2,100	140		
		Toluene			--	4J		
		Ethylbenzene			980	--		
		m/p-xylene			1,800	--		
		o-xylene			1,200	--		
MW-8	Jan-90	Benzene			--	2J		
MW-9	Feb-90				--	--		
MW-10	Oct-91			--		--		
MW-11	Oct-91					--		
MW-12	Oct-91					--		

Note: Blanks indicate sample not analyzed
-- indicates analyte not detected
all results in ug/kg
J = Compound detected, but below the laboatory reporting limit; value shown represents a laboratory estimated concentration.

022/731296/9.XLS

2.4.2.2 Depth Interval 3 to 5 feet

Soil COPC VOCs were detected in 4 of the 18 soil samples analyzed from the 3- to 5-foot depth interval. The only VOCs detected were ethylbenzene in HB-1 at 120,000 μg/kg, o-xylene in HB-1 at 1,900,000 μg/kg, benzene in AB-2 at 1 μg/kg (estimated), methylene chloride in AB-7 at 130 μg/kg (in method blank also), and methylene chloride in MW-2 at 5 μg/kg.

Eighteen soil samples were collected from the 3- to 5-foot bgs interval and analyzed for metals and SVOCs. Arsenic was detected at 20.7 mg/kg and 29 mg/kg from soil samples collected at MW-12 and HB-4, respectively. Beryllium and chromium were detected at 1 mg/kg and 28.6 mg/kg, respectively, at MW-10. Cadmium was detected at 3.3 mg/kg at AB-6 and thallium was detected at 1.1 mg/kg and 1.2 mg/kg at AB-1 and AB-2, respectively.

Fourteen of the eighteen soil samples analyzed for SVOCs measured non-detect. At three locations (HB-1, HB-2, and AB-2) naphthalene concentrations of 1,600 μg/kg, 570 μg/kg, and 1,200 μg/kg, respectively were detected. Also, benzo(b)fluoranthene was detected at 170 μg/kg in the soil sample collected at AB-4.

2.4.2.3 Depth Interval 8 to 10 feet

COPC VOCs were detected in 6 of the 18 soil samples collected from the 8- to 10-foot depth interval. The sample results were as follows: AB-1 contained ethylbenzene at 6,700 μg/kg, m/p-xylene at 6,000 μg/kg, and o-xylene at 12,000 μg/kg; AB-3 contained benzene at 39 μg/kg; AB-4 contained acetone at 250 μg/kg, o-xylene at 51 μg/kg, m/p-xylene at 36 μg/kg, and ethylbenzene at 20 μg/kg; AB-6 contained benzene at 1 μg/kg (estimated); AB-14 contained benzene at 15,000 μg/kg, ethylbenzene at 15,000 μg/kg, m/p-xylene at 15,000 μg/kg, and o-xylene at 27,000 μg/kg; and MW-7 contained benzene at 2,100 μg/kg, ethylbenzene at 980 μg/kg, m/p-xylene at 1,200 μg/kg, o-xylene at 1,200 μg/kg, and 1,1,1-TCA at 86 μg/kg (estimated).

Seventeen soil samples were collected at the 8- to 10-foot depth interval at the HWSA and analyzed for metals and SVOCs. Significant metal detections include arsenic (23 mg/kg and 26 mg/kg at MW-8 and MW-5, respectively), and thallium (10.5 mg/kg at MW-3). SVOCs were not detected in 13 of the 17 samples. Naphthalene (130 μg/kg at AB-1; 1,800 μg/kg at AB-2; 880 μg/kg at AB-4; and 460 μg/kg at AB-14) appears to be the only potentially significant SVOC detected at this depth interval.

2.4.2.4 Depth Interval 13 to 15 feet

COPC VOCs were detected in 6 of the 11 soil samples collected from the 13- to 15-foot depth interval. The sample results were as follows: AB-15 contained 640 μg/kg acetone and 250 μg/kg ethylbenzene; MW-1 contained 1,700 μg/kg ethylbenzene and 1,600 μg/kg o-xylene; MW-5 contained 7,400 μg/kg ethylbenzene, 1,900 μg/kg m/p-xylene, and 7,000 μg/kg o-xylene; MW-6 contained 1 μg/kg (estimated) toluene, 59 μg/kg vinyl chloride, 2 μg/kg (estimated) 1,1-DCE, 1,000 μg/kg trans-1,2-DCE, and

40 μg/kg TCE; MW-7 contained 140 μg/kg benzene and 4 μg/kg (estimated) toluene; and, MW-8 contained 2 μg/kg (estimated) benzene.

2.4.2.5 Depth Interval Greater than 15 feet

COPC VOCs were detected in 3 of the 7 soil samples collected below 15 feet. Benzene was detected at 6 μg/kg in the sample from 21 to 23 feet in boring AB-14. Trichloroethene was detected at 4 μg/kg (estimated) in the sample from 25 to 27 feet in boring AB-15. Benzene was detected at 1,900 μg/kg, ethylbenzene was detected at 11,000 μg/kg, and o-xylene was detected at 20,000 μg/kg in the sample from 14 to 16 feet in boring MW-1.

2.4.2.6 UST Closure Soil Sampling

Soil samples were collected as part of the UST closure activities conducted in 1994 through 1996 for the 15 former USTs (Tanks #47 through #57, #106, #160, #161, and #162) located at, or near, the HWSA (Ogden, 1995). Soil sample results shown in Table 2.3 for *cis*-1,2-DCE, *trans*-1,2-DCE, methyl ethyl ketone, 1,1,2,2-tetrachloroethene, TCE, and vinyl chloride all represent the maximum detected site concentration for these compounds. The two soil samples represented by these values were collected from the western end of the excavation for the former Tank #48 at the bottom of the pit.

2.4.2.7 LIF Results

As part of the 1995 natural attenuation investigation (Parsons ES, 1997), LIF readings were taken at 17 CPT boreholes at the HWSA (Figure 2.3). Fluorescence peaks were noted in 9 of the borings (LIF-3 at 22 feet, LIF-7 at 12.5 feet, LIF-11 at 13.5 feet, LIF-12 at 14 feet, LIF-13 at 18 feet, LIF-14 at 9 feet, LIF-15 at 12 feet, LIF-16 at 14 feet, and LIF-17 at 20 feet). The LIF data correspond fairly well with the analytical data, indicating contamination generally in the same areas and depth intervals.

2.4.3 Groundwater Data

Groundwater samples have been collected and analyzed from 12 monitoring wells and 34 small-diameter monitoring points at HWSA (Figure 2.3). The majority of the samples collected were for analysis of VOCs. However, samples also have been collected from the monitoring wells for analysis of SVOCs, pesticides, herbicides, PCBs, and metals. The following discussion focuses primarily on only those VOC compounds identified as groundwater COPCs, due to their increased mobility.

Both aromatic and chlorinated aliphatic hydrocarbons have been detected in the groundwater samples from HWSA. The aromatics that have been detected are BTEX. The chlorinated aliphatics detected are TCE, cis-1,2-DCE, trans-1,2-DCE, 1,1-DCE, 1,2-DCA, and vinyl chloride. The maximum analytical results for aromatic and chlorinated aliphatic hydrocarbons detected in groundwater during sampling events conducted between September 1988 and December 1996 are summarized in Table 2.6.

Table 2.6
BTEX and Chlorinated VOCs Detected in Groundwater
September 1988 - December 1996
Hazardous Waste Storage Area
Rickenbacker ANGB, Ohio

Sample Location	Sample Date	Benzene (μg/L)	Toluene (μg/L)	Ethylbenzene (μg/L)	Total Xylenes (μg/L)	Total BTEX (μg/L)	Vinyl Chloride (μg/L)	1,1-DCE (μg/L)	T-1,2-DCE (μg/L)	C-1,2-DCE (μg/L)	1,2-DCE (total) (μg/L)	1,2-DCA (μg/L)	TCE (μg/L)	1,1,1-TCA (μg/L)
ESMP-1S	Feb-95	--[a]	BLQ[b]	--	--	BLQ	--	--	--	--		--	--	
ESMP-1D	Feb-95	--	BLQ	BLQ	--	BLQ	--	--	--	--		--	--	
ESMP-2S	Feb-95	--	3.6	--	--	3.6	--	--	--	--		--	--	
ESMP-2D	Feb-95	--	1.05	--	--	1.05	--	--	1.00	BCL[c]	1.00	--	95.60	--
	Aug-95	--	--	--	--	--	--	--	--	--	--	--	20	--
	Dec-95	--	--	--	--	--	--	--	--	--	--	--	14	--
	Mar-96	--	--	--	--	--	--	--	--	--	--	--	9	--
	Jun-96	--	--	--			--	--	--	--	--	--	6.5	--
	Sep-96	--	--	--			--	--	--	--	--	--	7.7	--
	Dec-96	--	--	--	1.5J[d]	1.5J	--	--	--	--	--	--	3J	--
ESMP-3S	Feb-95	--	--	--	--	--	--	--	--	BCL	BCL	--	1.00	
ESMP-3D	Feb-95	--	BLQ	--	--	BLQ	--	--	--	1.3	1.3	--	6.5	--
	Aug-95	--	--	--	--	--	--	--	--	--	--	--	--	--
	Dec-95	--	--	--	--	--	--	--	--	--	--	--	--	--
	Mar-96	--	--	--	--	--	--	--	--	--	--	--	--	--
	Jun-96	--	--	--	--	--	--	--	--	--	--	--	--	--
	Sep-96	--	--	--	--	--	--	--	--	--	--	--	--	--
	Dec-96	--	--	--	4.5J	4.5J	--	--	--	--	--	--	--	--
ESMP-4S	Feb-95	--	BLQ	--	--	BLQ	1.00	--	--	--	--	--	--	--
	Aug-95	--	--	--	--	--	--	--	--	--	--	--	--	--
	Dec-95	--	--	--	--	--	--	--	--	--	--	--	--	--
	Mar-96	--	--	--	--	--	--	--	--	--	--	--	--	--
	Jun-96	--	--	--	--	--	--	--	--	--	--	--	--	--
	Sep-96	--	--	--	--	--	--	--	--	--	--	--	--	--
	Dec-96	--	--	--	--	--	22	--	--	--	--	--	--	--
ESMP-4D	Feb-95	--	2.48	--	--	2.48	16	--	--	--	--	--	--	--
	Aug-95	--	--	--	--	--	15	--	--	--	--	--	--	--
	Dec-95	--	--	--	--	--	15	--	--	--	--	--	--	--
	Mar-96	--	--	--	--	--	19	--	--	--	--	--	--	--
	Jun-96	--	--	--	--	--	17	--	--	--	--	--	--	--
	Sep-96	--	--	--	--	--	17	--	--	--	--	--	--	--
	Dec-96	--	--	--	--	--	22	--	--	--	--	--	--	--
ESMP-5S	Feb-95	--	--	--	--	--	--	--	--	--	--	--	--	--
ESMP-5D	Feb-95	--	--	--	--	--	--	--	--	--	--	--	--	--
ESMP-6S	Feb-95	--	3.13	--	--	3.13	NA[e]	NA	NA	NA	NA	NA	NA	--
ESMP-6D	Feb-95	--	--	--	--	--	1.70	--	--	--	--	--	--	--
	Aug-95	--	--	--	--	--	--	--	--	--	--	--	--	--
	Dec-95	--	--	--	--	--	2.0	--	--	--	--	--	--	--
	Mar-96	--	--	--	--	--	1.9 J	--	--	--	--	--	--	--
	Jun-96	--	--	--	--	--	1.7J	--	--	--	--	--	--	--
	Sep-96	--	--	--	--	--	--	--	--	--	--	--	--	--
	Dec-96	--	--	--	--	--	--	--	--	--	--	--	--	--
ESMP-7S	Feb-95	--	--	--	--	--	--	--	--	--	--	--	--	--
ESMP-7D	Feb-95	--	BLQ	--	--	BLQ	--	--	--	--	--	--	--	--

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Table 2.6 (Continued)
BTEX and Chlorinated VOCs Detected in Groundwater
September 1988 - December 1996
Hazardous Waste Storage Area
Rickenbacker ANGB, Ohio

Sample Location	Sample Date	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Total Xylenes (µg/L)	Total BTEX (µg/L)	Vinyl Chloride (µg/L)	1,1-DCE (µg/L)	T-1,2-DCE (µg/L)	C-1,2-DCE (µg/L)	1,2-DCE (total) (µg/L)	1,2-DCA (µg/L)	TCE (µg/L)	1,1,1-TCA (µg/L)
ESMP-8S	Feb-95	--	1.30	--	--	1.30	--	--	--	--	--	--	BCL	--
	Aug-95	--	--	--	--	--	--	--	--	--	--	--	--	--
	Dec-95	--	--	--	--	--	--	--	--	--	--	--	--	--
	Mar-96	--	--	--	--	--	--	--	--	--	--	--	--	--
	Jun-96	--	--	--	--	--	--	--	--	--	--	--	--	--
	Sep-96	--	--	--	--	--	--	--	--	--	--	--	--	--
	Dec-96	--	--	--	--	--	--	--	--	--	--	--	--	--
ESMP-8DD	Feb-95	--	BLQ	--	BLQ	BLQ	--	--	--	--	--	--	BCL	--
ESMP-9S	Feb-95	--	BLQ	--	--	BLQ	--	--	--	--	--	--	BCL	--
ESMP-9D	Feb-95	--	--	--	--	--	--	--	--	--	--	--	--	--
ESMP-10S	Feb-95	--	BLQ	--	--	BLQ	--	--	--	--	--	--	1.00	--
	Aug-95	--	--	--	--	--	--	--	--	--	--	--	--	--
	Dec-95	--	--	--	--	--	--	--	--	--	--	--	--	--
	Mar-96	--	--	--	--	--	--	--	--	--	--	--	--	--
	Jun-96	--	--	--			--	--	--	--	--	--	--	--
	Sep-96	--	--	--			--	--	--	--	--	--	--	--
	Dec-96	--	--	--	6.4	6.4	--	--	--	--	--	--	--	--
ESMP-10D	Feb-95	--	--	--	--	--	--	--	--	--	--	--	--	
ESMP-11D	Feb-95	BLQ	BLQ	BLQ	BLQ	BLQ	--	--	--	--	--	--	--	
ESMP-12S	Mar-95	--	2.44	--	--	2.44	--	--	--	--	--	220.00	BCL	
ESMP-13S	Feb-95	424.18	22.41	237.09	279.58	963	2.7	1.3	300	228	528	--	45.6	--
	Aug-95	200	--	130	100	430	--	--	430	--	--	--	--	--
	Dec-95	270	8.9 J	140	90	509	--	--	230	180	410	--	--	--
	Mar-96	280	8.2 J	120	34	442	62	--	230	210	440	--	--	--
	Jun-96	300	6.7	120	50	477	120	--	190	200	390	--	--	--
	Sep-96	390	10	160	100	660	72	--	5J	9.8	15J	--	--	--
	Dec-96	510	25J	190	77	777	41	--	--	--	--	--	--	--
ESMP-13D	Feb-95	--	--	BLQ	--	BLQ	--	--	--	--	--	--	--	--
ESMP-13D(D)	Feb-95	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--
ESMP-14S	Feb-95	--	--	--	--	--	--	--	--	--	--	--	--	--
ESMP-14S(D)	Feb-95	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--
ESMP-14D	Feb-95	--	--	--	--	--	1.00	--	--	2.2	2.2	--	--	--
	Aug-95	--	--	--	--	--	--	--	--	--	--	--	--	--
	Dec-95	--	--	--	--	--	--	--	--	4.1J	4.1J	--	--	--
	Mar-96	--	--	--	--	--	--	--	--	5.8	5.8	--	--	--
	Jun-96	--	--	--	--	--		--	--	5.0	5.0	--	--	--
	Sep-96	--	--	--	--	--	2.1	--	8.5	--	8.5	--	--	--
	Dec-96	--	--	--	--	--	2.8	--	--	11	11	--	--	--
ESMP-14DD	Feb-95	--	BLQ	--	--	BLQ	--	--	--	--	--	--	BCL	--
ESMP-15S	Feb-95	--	1.08	--	--	1.08	--	--	--	--	--	--	--	--
ESMP-15D	Feb-95	--	--	--	--	--	--	--	--	--	--	--	--	--
ESMP-16S	Mar-95	89.18	BLQ	228.5	153.65	471.33	--	--	--	BCL	BCL	--	--	--
	Aug-95	23	--	23.00	7.00	53	--	--	--	--	--	--	--	--
	Dec-95	5	--	5	5	15	--	--	--	--	--	--	--	--
	Mar-96	18	--	--	--	18	--	--	--	--	--	--	--	--
	Jun-96	3.1J	--	--	--	3.1J	--	--	--	--	--	--	--	--
	Sep-96	11	--	--	--	11	--	--	--	--	--	--	--	--
	Dec-96	9.1	--	--	--	9.1	--	--	--	--	--	--	--	--

Table 2.6 (Continued)
BTEX and Chlorinated VOCs Detected in Groundwater
September 1988 - December 1996
Hazardous Waste Storage Area
Rickenbacker ANGB, Ohio

Sample Location	Sample Date	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Total Xylenes (µg/L)	Total BTEX (µg/L)	Vinyl Chloride (µg/L)	1,1-DCE (µg/L)	T-1,2-DCE (µg/L)	C-1,2-DCE (µg/L)	1,2-DCE (total) (µg/L)	1,2-DCA (µg/L)	TCE (µg/L)	1,1,1-TCA (µg/L)
ESMP-16D	Mar-95	6.46	BLQ	26.87	62.03	95.36	--	--	--	BCL	BCL	--	--	--
	Aug-95	--	--	--	--	--	--	--	--	--	--	--	--	--
	Dec-95	--	--	--	--	--	--	--	--	--	--	--	--	--
	Mar-96	--	--	--	--	--	--	--	--	--	--	--	--	--
	Jun-96	--	--	--	--	--	--	--	--	--	--	--	--	--
	Sep-96	--	--	--	--	--	--	--	--	--	--	--	--	--
	Dec-96	--	--	--	3.8J	3.8J	--	--	--	--	--	--	--	--
ESMP-17S	Feb-95	--	--	--	--	--	1570	11.7	152	4913	5065	--	BCL	--
	Aug-95	--	--	--	--	--	930E f/	--	7730E	--	7730E	--	--	--
	Dec-95	--	--	--	--	--	1200	9.9	130	4200	4330	--	--	--
	Mar-96	--	--	--	--	--	670	--	130	2800	2930	--	--	--
	Jun-96	--	--	--	--	--	500	5.7	93	3000	3093	--	--	--
	Sep-96	--	--	--	--	--	460E	5	1800E	78	1878E	--	--	--
	Dec-96	--	--	--	--	--	210D g/	2.3J	48	1500E	1548E	--	--	--
MW-1	Sep-88	94	--	--	--	--	--	--	--	--	--	--	--	--
	Feb-90	560	--	110	121	--	--	--	--	--	--	--	--	--
MW-2	Sep-88	--	--	--	--	--	--	--	--	--	--	--	--	--
	Feb-90	--	--	--	--	--	--	--	--	--	--	--	--	--
	Oct-91	--	--	--	--	--	--	--	--	--	--	--	--	2J
	Mar-95	BLQ	BLQ	BLQ	BLQ	BLQ	--	--	--	--	--	--	--	--
	Sep-96	--	--	--	--	--	--	--	--	--	--	--	--	--
	Dec-96	--	--	--	3.2J	--	--	--	--	--	--	--	--	--
MW-3	Sep-88	--	--	--	--	--	--	--	--	--	--	--	44	--
	Feb-90	--	--	--	--	--	--	--	--	--	--	--	7	--
	Oct-91	--	--	--	--	--	--	--	--	--	--	--	10	--
	Feb-95	BLQ	BLQ	BLQ	BLQ	BLQ	--	--	--	BLC	BLC	--	1	--
	Aug-95	--	--	--	--	--	--	--	--	--	--	--	--	--
	Dec-95	--	--	--	--	--	--	--	--	--	--	--	--	--
	Mar-96	--	--	--	--	--	--	--	--	--	--	--	--	--
	Jun-96	--	--	--	--	--	--	--	--	--	--	--	--	--
	Sep-96	--	--	--	--	--	--	--	--	--	--	--	5J	--
	Dec-96	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-4	Feb-90	--	--	--	--	--	--	--	--	--	--	--	--	--
	Oct-91	--	--	--	--	--	--	--	--	--	--	--	--	--
	Mar-95	BLQ	BLQ	BLQ	BLQ	BLQ	--	--	--	--	--	--	--	--
	Aug-95	--	--	--	--	--	--	--	--	--	--	--	--	--
	Dec-95	--	--	--	--	--	--	--	--	--	--	--	--	--
	Mar-96	--	--	--	--	--	--	--	--	--	--	--	--	--
	Jun-96	--	--	--	--	--	--	--	--	--	--	--	--	--
	Sep-96	--	--	--	--	--	--	--	--	--	--	--	--	--
	Dec-96	--	--	--	6.2	6.2	--	--	--	--	--	--	--	--
MW-5	Mar-95	17.19	41.94	317.97	375.93	753	--	--	--	--	--	--	--	--
	Aug-95	--	15	170	210	395	--	--	--	--	--	--	--	--
	Dec-95	--	12 J	140	190	342	--	--	--	--	--	--	--	--
	Mar-96	--	4.8 J	54	100	159	--	--	--	--	--	--	--	--
	Jun-96	--	13J	190	210	413	--	--	--	--	--	--	--	--
	Sep-96	--	7.6	150	180	338	--	--	--	--	--	--	--	--
	Dec-96	--	--	230	290	520	--	--	--	--	--	--	--	--

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Table 2.6 (Continued)
BTEX and Chlorinated VOCs Detected in Groundwater
September 1988 - December 1996
Hazardous Waste Storage Area
Rickenbacker ANGB, Ohio

Sample Location	Sample Date	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Total Xylenes (µg/L)	Total BTEX (µg/L)	Vinyl Chloride (µg/L)	1,1-DCE (µg/L)	T-1,2-DCE (µg/L)	C-1,2-DCE (µg/L)	1,2-DCE (total) (µg/L)	1,2-DCA (µg/L)	TCE (µg/L)	1,1,1-TCA (µg/L)
MW-6	Feb-90	--	--	--	--	--	--	--	8	--	8	--	78	--
	Oct-91	--	--	--	--	--	--	--	--	--	190	--	2000	--
	Feb-95	NA	NA	NA	NA	NA	21.9	6.5	43.2	794	837.2	--	9580	--
	Aug-95	--	--	--	--	--	--	--	--	--	--	--	770	--
	Dec-95	--	--	--	--	--	--	--	--	27	27.00	--	180	--
	Mar-96	--	--	--	--	--	--	--	--	--	--	--	11	--
	Jun-96	--	--	--	--	--	--	--	1.7J	26	28J	--	560	--
	Sep-96	--	--	--	--	--	--	--	18		18	--	220	--
	Dec-96	--	--	--	--	--	--	--	--	10	10	--	130	--
MW-7	Feb-90	200	--	90	70	--	--	--	--	--	--	--	--	--
	Oct-91	19	2J	62	36	--	17	--	--	--	--	--	--	--
MW-8	Feb-90	--	--	--	--	--	--	--	--	--	--	--	--	--
	Oct-91	--	--	--	--	--	--	--	--	--	--	--	--	3J
	Feb-95	BLQ	--	--	--	BLQ	--	--	--	--	--	--	BCL	--
	Aug-95	--	--	--	--	--	--	--	--	--	--	--	--	--
	Dec-95	--	--	--	--	--	--	--	--	--	--	--	--	--
	Mar-96	--	--	--	--	--	--	--	--	--	--	--	--	--
	Jun-96	--	--	--	--	--	--	--	--	--	--	--	--	--
	Sep-96	--	--	--	--	--	--	--	--	--	--	--	--	--
	Dec-96	--	--	--	4.8J	4.8J	--	--	--	--	--	--	--	--
MW-9	Feb-90	--	--	--	--	--	--	--	--	--	--	--	--	--
	Oct-91	--	--	--	--	--	--	--	--	--	--	--	--	--
	Mar-95	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-10	Oct-91	--	--	--	--	--	--	--	--	--	--	--	--	--
	Mar-95	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-11	Oct-91	--	--	--	--	--	--	--	--	--	--	--	--	--
	Feb-95	--	--	--	--	--	--	--	--	--	--	--	--	--
	Aug-95	--	--	--	--	--	--	--	--	--	--	--	--	--
	Dec-95	--	--	--	--	--	--	--	--	--	--	--	--	--
	Mar-96	--	--	--	--	--	--	--	--	--	--	--	--	--
	Jun-96	--	--	--	--	--	--	--	--	--	--	--	--	--
	Sep-96	--	--	--	--	--	--	--	--	--	--	--	--	--
	Dec-96	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-12	Oct-91	--												
	Feb-95	--	BLQ	--	--	BLQ	--	--	--	--	--	--	--	--
	Aug-95	--	--	--	--	--	--	--	--	--	--	--	--	--
	Dec-95	--	--	--	--	--	--	--	--	--	--	--	--	--
	Mar-96	--	--	--	--	--	--	--	--	--	--	--	--	--
	Jun-96	--	--	--	--	--	--	--	--	--	--	--	--	--
	Sep-96	--	--	--	--	--	--	--	--	--	--	--	--	--
	Dec-96	--	--	--	--	--	--	--	--	--	--	--	--	--

a/ -- = Not detected.
b/ BLQ Below limit of quantitation.
c/ BCL= Below calibration limit (1.0 mg/L).
d/ J = Compound detected, but below the laboratory reporting limit; value shown represents a laboratory estimated concentration.
e/ NA= Not analyzed.
f/ E = Concentration exceeded upper calibration standard; value shown represents an estimated concentration.
g/ D = Compound analyzed at a secondary dilution factor.

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Figures 2.10 through 2.15 are graphs of selected VOC concentrations through time for samples collected from MW-5 and MW-6 and ESMP-2d, ESMP-16S, ESMP-13S, and ESMP-17S. As these data indicate, the concentration of VOCs in the groundwater underlying the HWSA is generally decreasing with time. The primary exception to this is the BTEX concentrations in samples collected from well MW-5 and monitoring point ESMP-13S. In both locations, the BTEX concentrations initially dropped, then rose again.

The approximate horizontal extent of chlorinated VOCs and BTEX in the groundwater at HWSA are shown in Figures 2.16 and 2.17, respectively. The highest chlorinated VOC concentrations were measured in groundwater samples collected from ESMP-17S. The downgradient extent of the chlorinated VOC plume shown in Figure 2.16 is inferred in part from Geoprobe groundwater sample results taken in August 1995. The locations and results of the August 1995 Geoprobe sampling are shown on Figure 2.16. These Geoprobe groundwater samples were collected from the same sand seam in which ESMP-17S is screened. The highest BTEX concentration has been measured at ESMP-13S, which is located adjacent to one of the former UST cavities at the site. The second highest concentration of BTEX was measured at MW-5, where free product has been detected in the past.

The majority of the chlorinated VOC contamination has been detected in groundwater samples collected from monitoring points screened across the sand and gravel zone located at a depth of approximately 14 to 18 feet bgs (i.e., ESMP-4D, ESMP-13S, and ESMP-17S). However, some chlorinated VOC contamination has also been detected in groundwater samples taken from the deeper sand seam located at a depth of approximately 21 to 25 feet bgs (i.e., ESMP-14D).

The most prevalent chlorinated VOC detected at the HWSA is vinyl chloride. During the December 1996 sampling event, vinyl chloride was detected in ESMP-4S (22 µg/L), ESMP-13S (41 µg/L), ESMP-14D (2.8 µg/L), and ESMP-17S (150 µg/L). Total 1,2-DCE detected during the December 1996 sampling event was 11 µg/L in ESMP-14D; 1,448 µg/L in ESMP-17S, and 10 µg/L in MW-6. TCE was detected in ESMP-2D (3 µg/L) and MW-6 (130 µg/L). No other chlorinated VOCs were detected in the groundwater samples collected during the December 1996 sampling event. 1,2-DCA was detected at 220 µg/L in a groundwater sample collected from ESMP-12S in March 1995. This represents the most recent sampling event at this location.

BTEX contamination is generally detected in groundwater samples collected from the shallow sand and gravel interval (i.e., ESMP-13S, ESMP-16S, and MW-5). During the December 1996 sampling event, the sample from ESMP-13S contained benzene (510 µg/L), toluene (25 µg/L), ethylbenzene (190 µg/L), and xylenes (77 µg/L). The sample from ESMP-16S contained benzene (9.1 µg/L). The sample from MW-5 contained ethylbenzene (230 µg/L) and xylenes (290 µg/L). Some xylene contamination was measured in the December 1996 groundwater samples collected from the deeper sand and gravel, which had previously not been detected during earlier sampling events. Low concentrations of xylenes were also detected in samples from other monitoring points that did not previously have contamination. These results do not appear to indicate that actual site conditions may be changing (worsening); rather, these low detections may be the result of laboratory contamination.

Figure 2.10
Selected VOC Concentrations
in MW-5

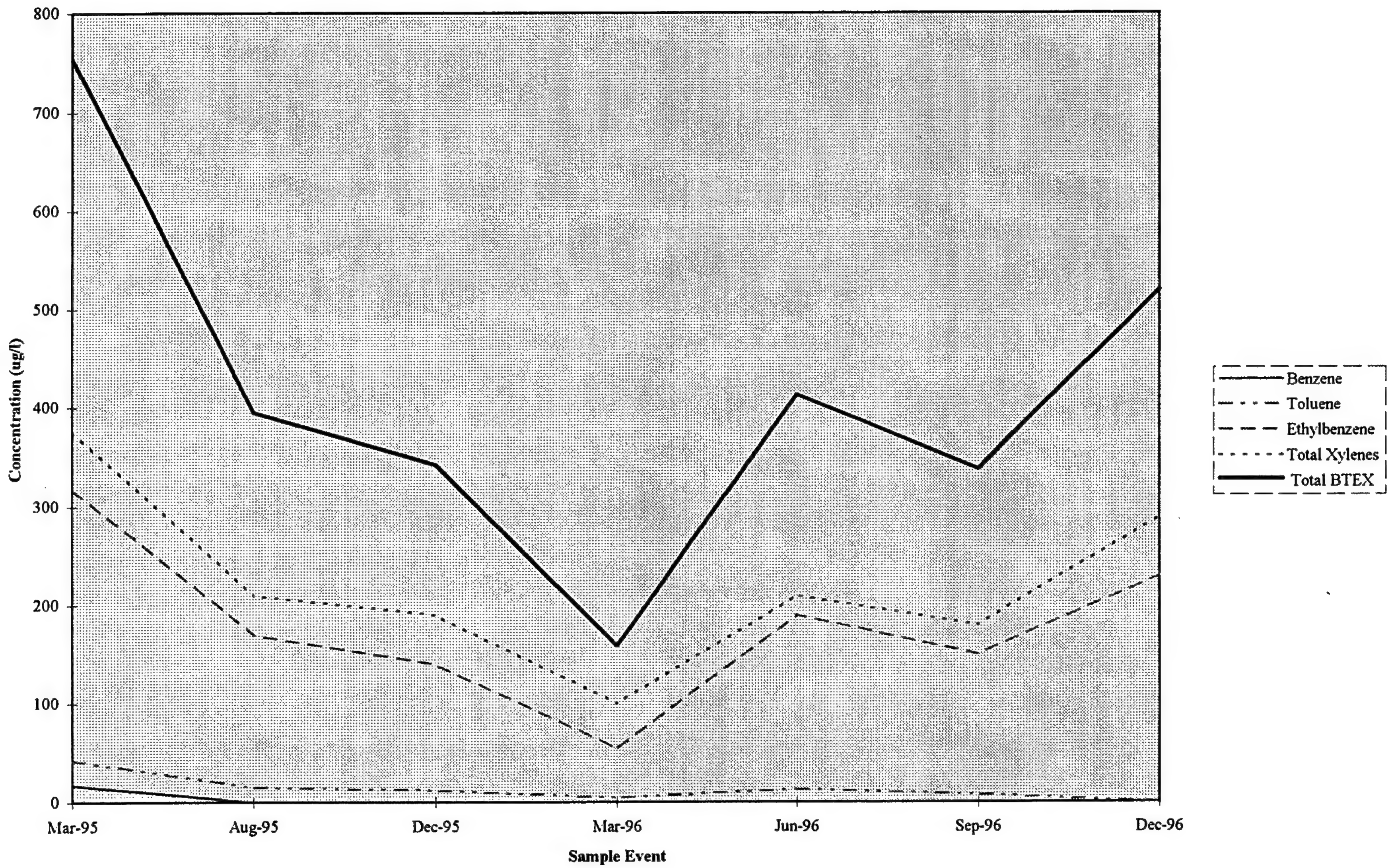

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Figure 2.11
Selected VOC Concentrations
in MW-6

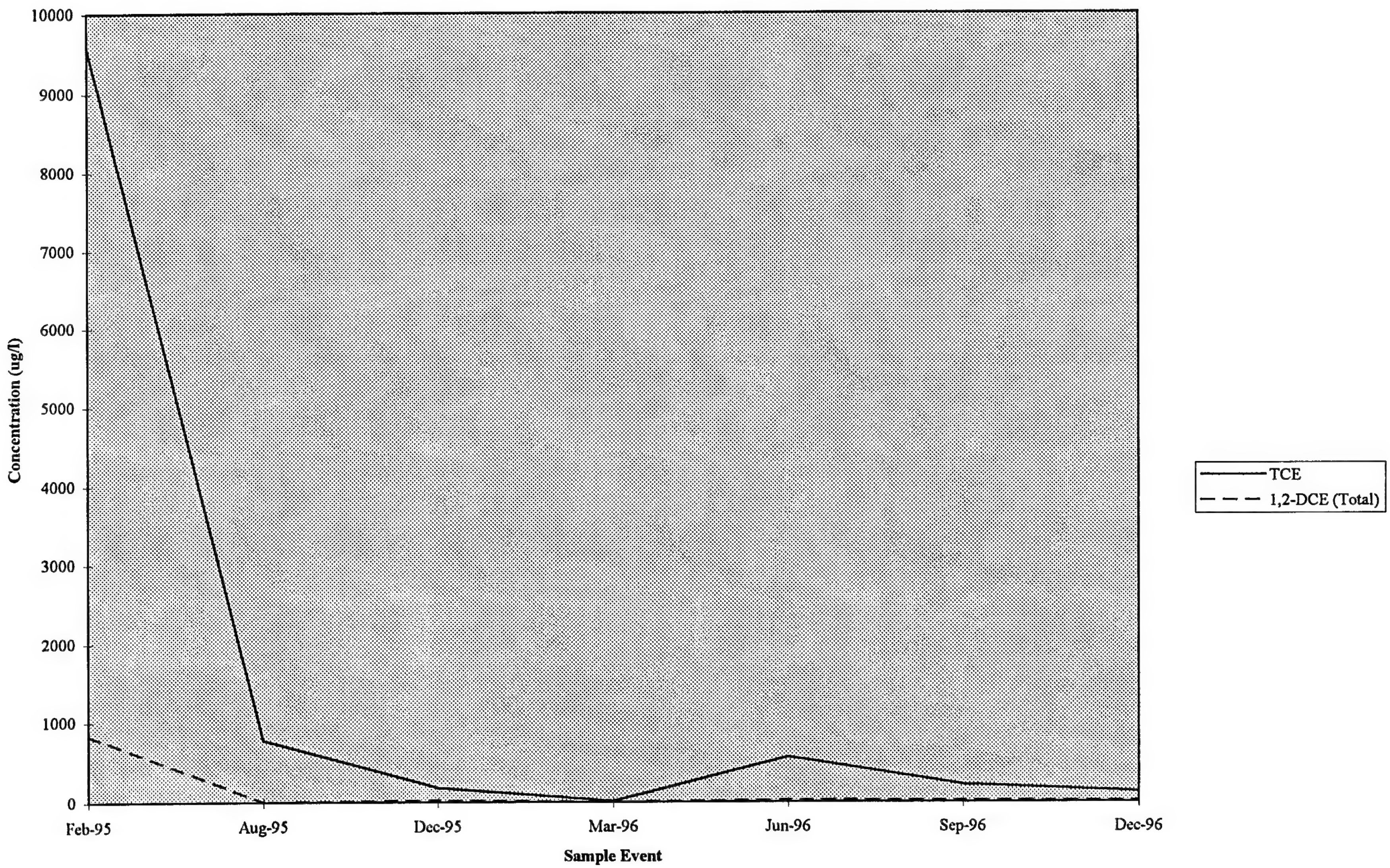

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Figure 2.12
TCE Concentration in
ESMP-2d

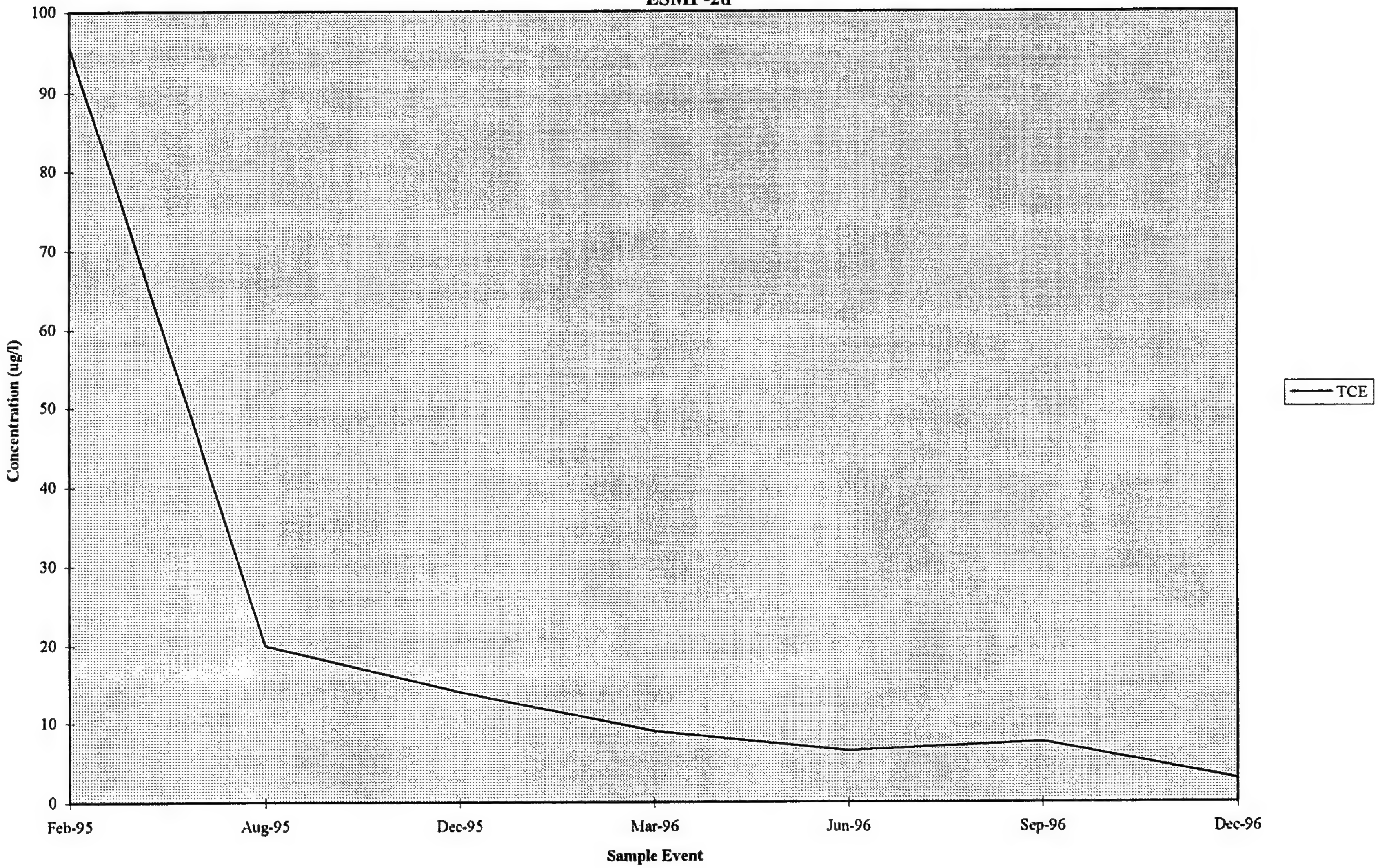

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Figure 2.13
Benzene Concentration
in ESMP-16s

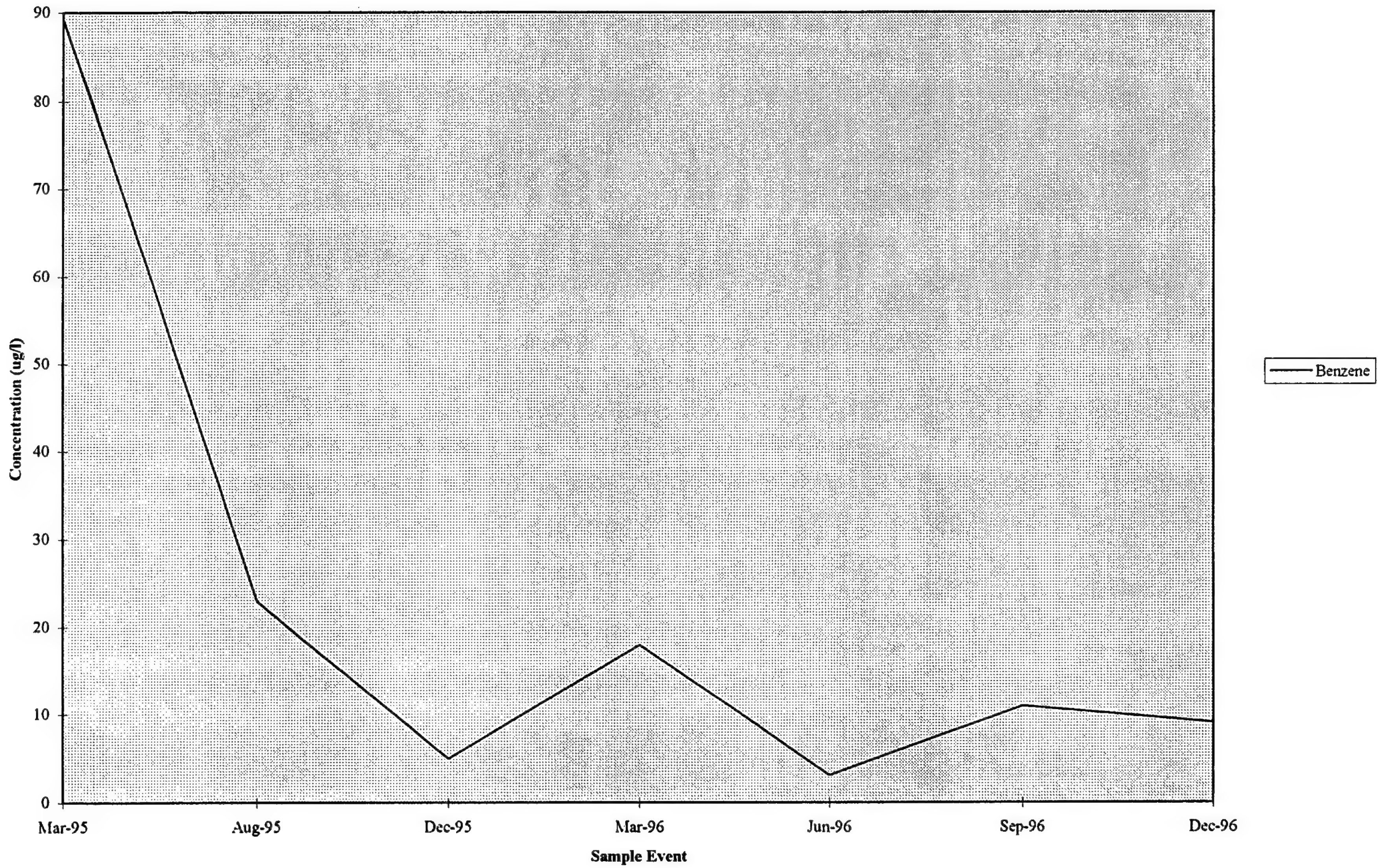

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Figure 2.14
Selected VOC Concentrations
in ESMP-13s

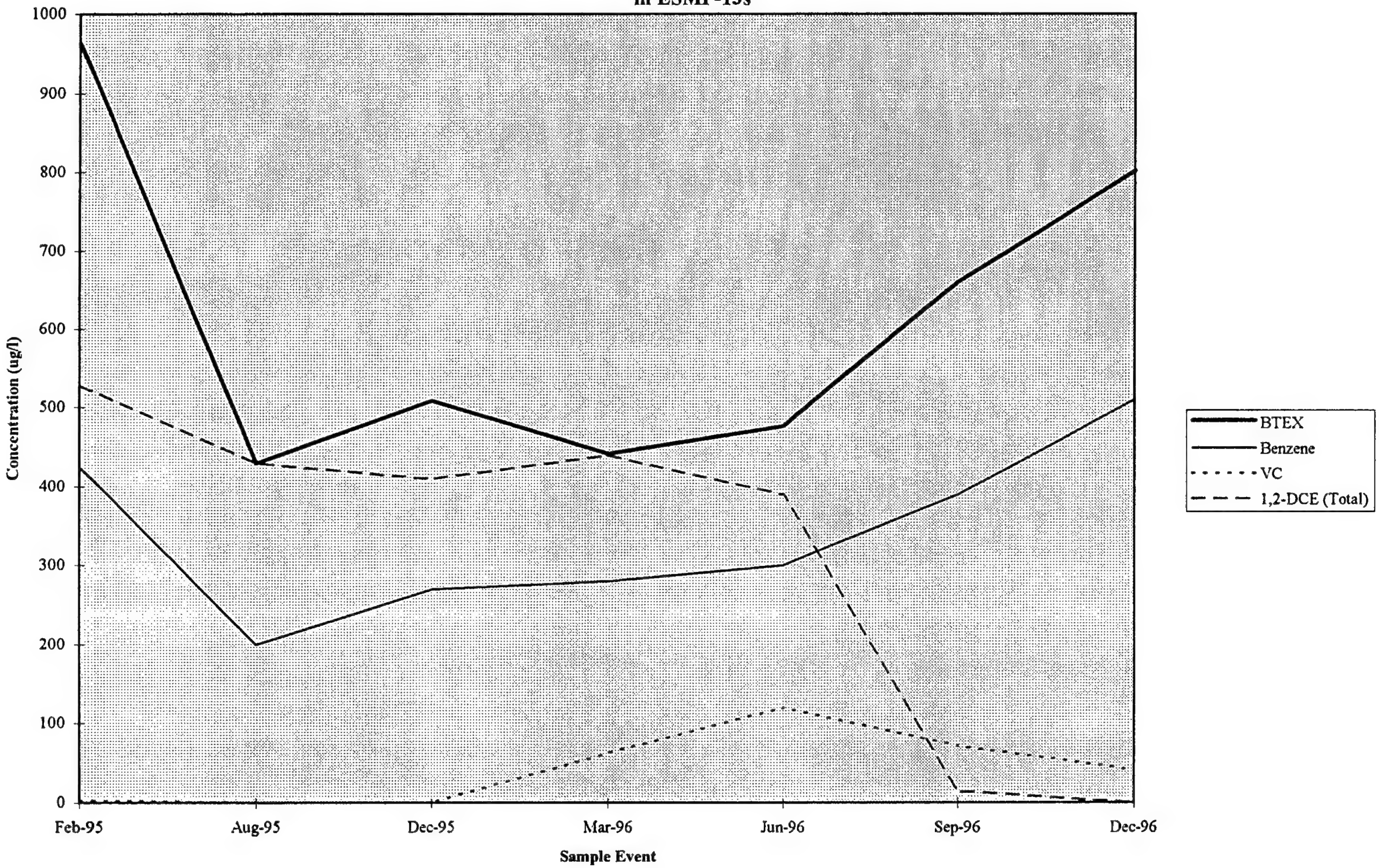

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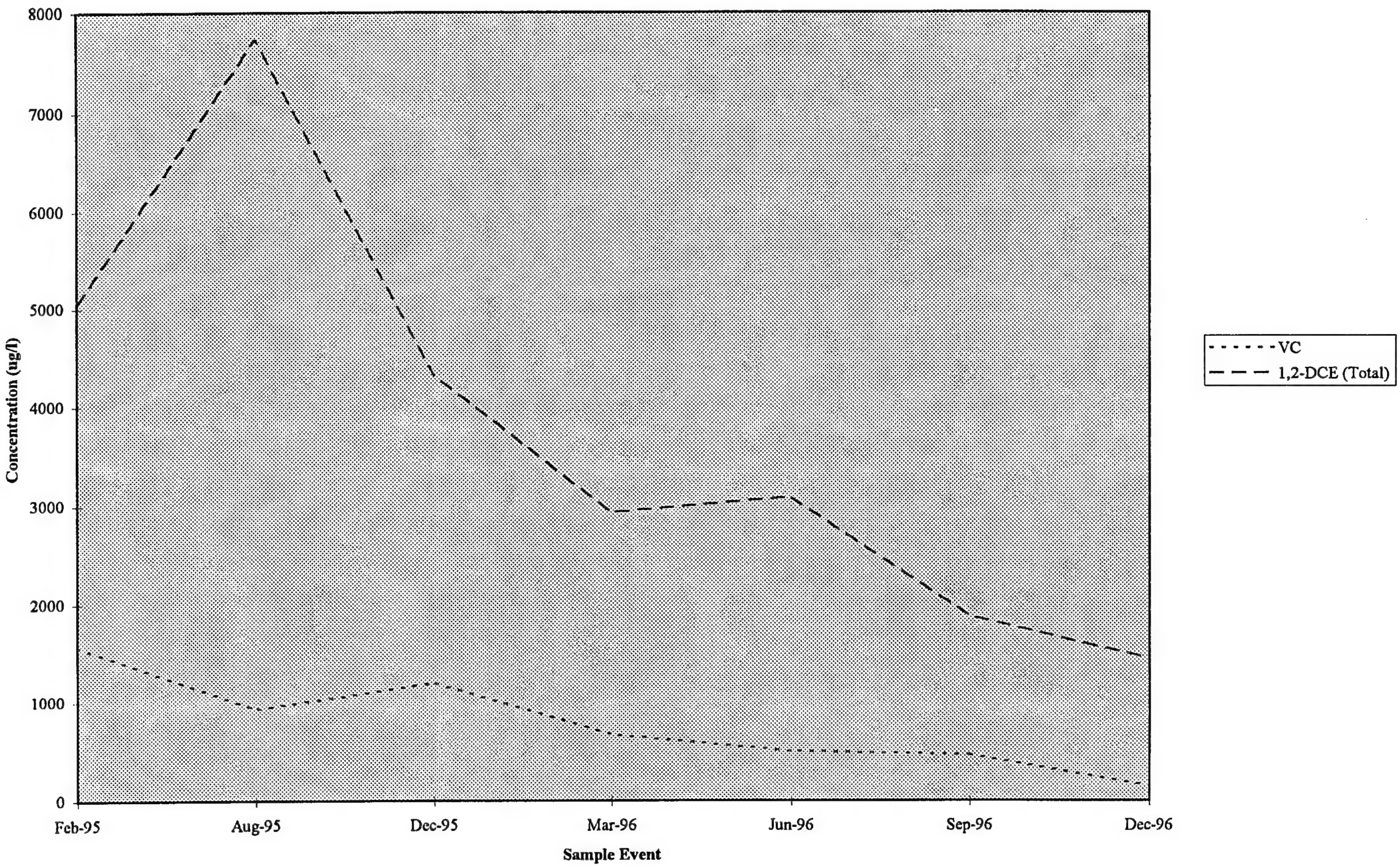
Figure 2.15
Selected VOC Concentrations
in ESMP-17s



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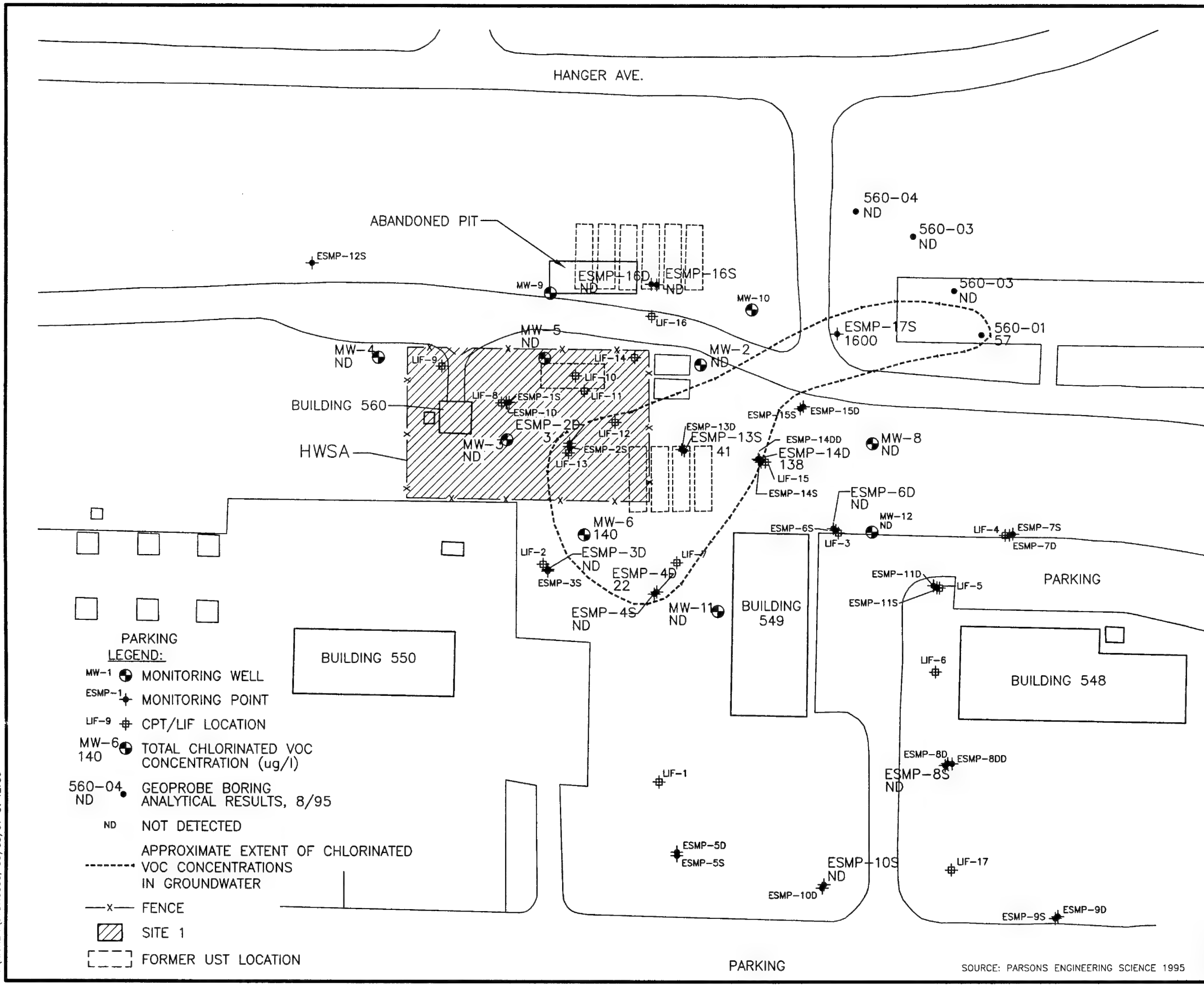

FIGURE 2.16

TOTAL CHLORINATED VOC CONCENTRATIONS IN GROUNDWATER DECEMBER 1996

HWSA
Rickenbacker, ANGB, Ohio

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Denver, Colorado

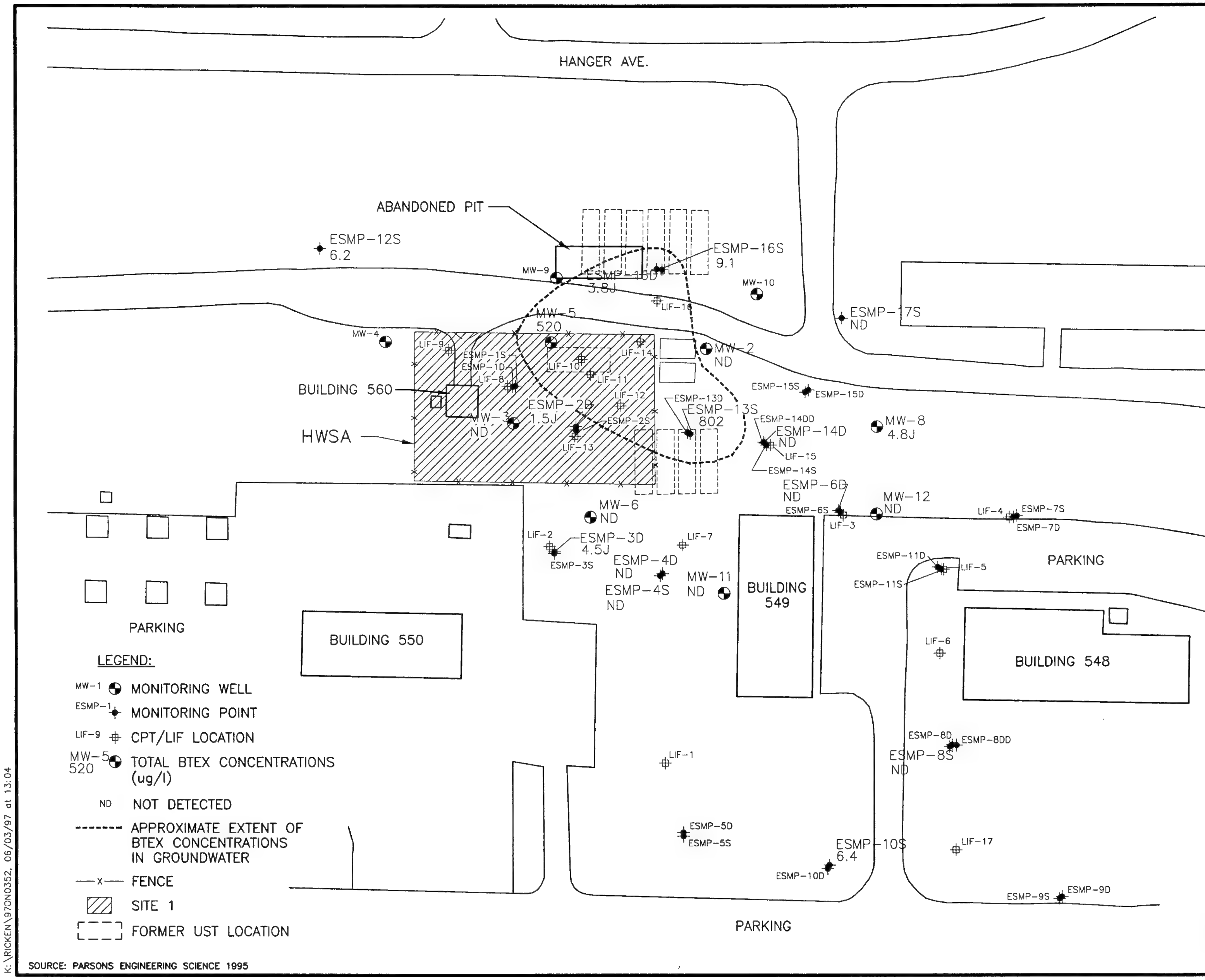

FIGURE 2.17

TOTAL BTEX CONCENTRATIONS IN GROUNDWATER DECEMBER 1996

HWSA
Rickenbacker ANGB, Ohio

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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One of the primary objectives of the additional assessment activities to be conducted at the HWSA, as described in this work plan, will be to confirm the suspected nature and extent of contamination in groundwater, particularly at the "leading edge" of the dissolved chlorinated VOC and BTEX plumes (Figures 2.16 and 2.17). The extent of the dissolved chlorinated VOC contamination, as implied by data collected in August 1995 downgradient from ESMP-17S, will be verified by installation and sampling of additional permanent monitoring points as will the dissolved BTEX contamination near ESMP-165. These data are also necessary to evaluate the need for engineered remediation of groundwater contamination (e.g., oxygenation) to protect potential receptors.

SECTION 3

BASIS FOR PROPOSED CLOSURE APPROACH

It is necessary to collect sufficient data to comparatively evaluate the long-term effectiveness of various remedial alternatives at eliminating or minimizing current or potential future risks to human health and the environment. Section 3.1 describes a conceptual site model for the HWSA, which includes possible source and release mechanisms, governing fate and transport processes, potential exposure points and routes, and potential human and environmental receptors. Sections 3.2 and 3.3 describe the currently proposed approaches for soil and groundwater remediation, respectively. Section 3.4 provides an overview of performance goal determination.

3.1 CONCEPTUAL SITE MODEL

The purpose of developing a conceptual site model (CSM) is to evaluate existing information about the physical characteristics of the site, including potential contaminant sources, chemicals of concern, release mechanisms (e.g., leaching and volatilization), governing fate and transport processes (e.g., molecular diffusion, groundwater migration), potential human and ecological receptors (e.g., current on-base workers, potential future on-base residents, current/future off-base residents, terrestrial wildlife), exposure points (i.e., locations where receptors could come into contact with site-related contamination), and routes of exposure (e.g., inhalation, incidental ingestion, dermal contact), to identify the types of data necessary to quantify receptor exposure. The CSM will be used to define the nature of additional site characterization activities required at the HWSA to support identification, selection, and implementation of a final remedial alternative that minimizes contaminant migration and receptor exposure. The CSM constructed for the HWSA is shown schematically in Figure 3.1.

3.1.1 Definitions

It is appropriate at this point to define some of the key terms used in the risk-based approach to remediation at the HWSA. A *risk assessment* is the process of defining and quantifying present and future risks to human health and the environment. This process includes the calculation of probabilities of risk because of the inherent uncertainty in predicting future risks. A *baseline risk assessment* estimates the risks that might exist if no remediation or institutional controls are applied at a site. A risk assessment merges the scientific process of estimating the magnitude and probability of effects (risk analysis) with the process of choosing among alternatives and determining the acceptability of risks (risk management). The objective of additional assessment activities proposed herein determine both baseline risks and establish performance objectives for the remedial/closure strategy to be implemented at the HWSA.

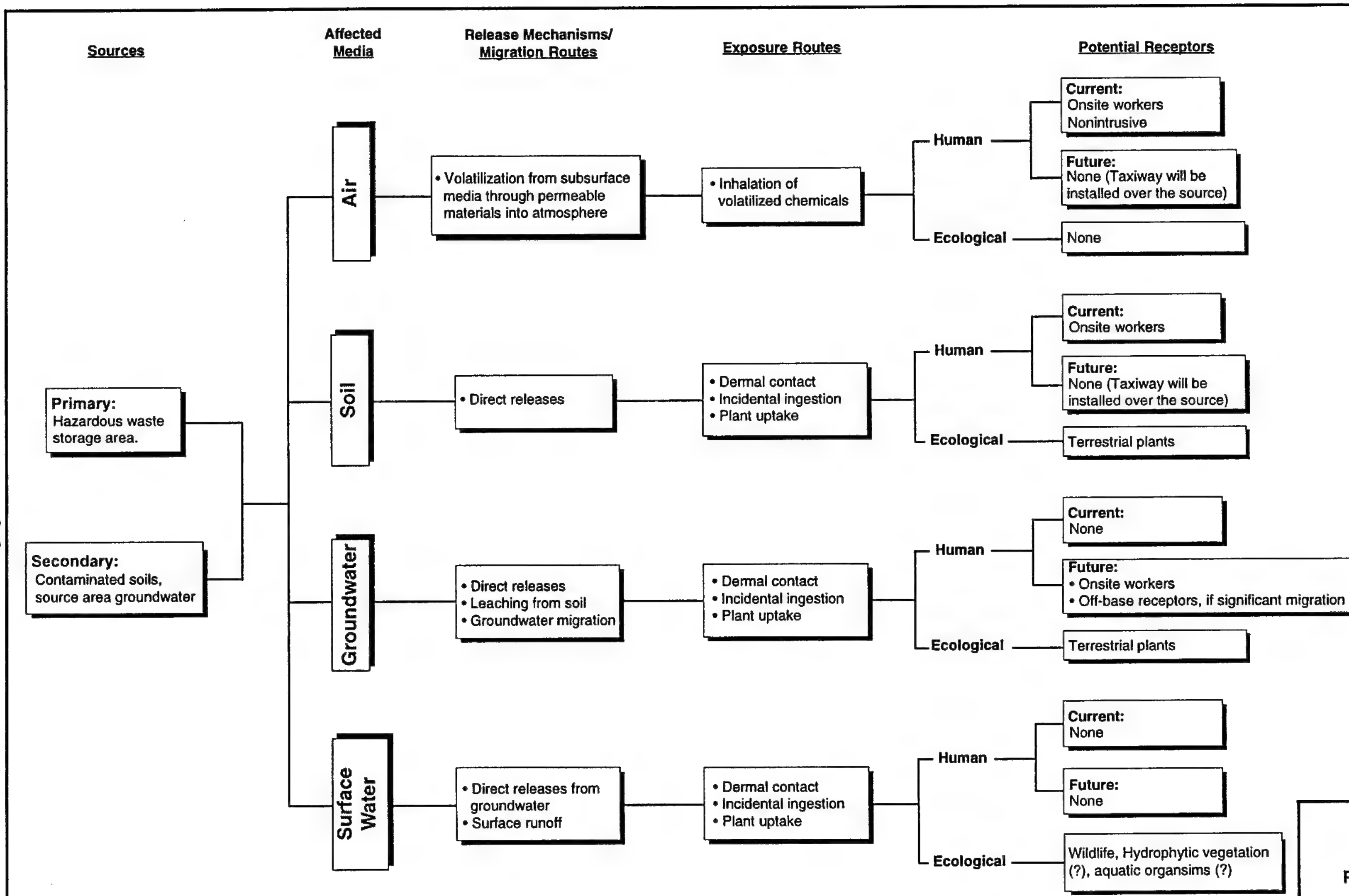

FIGURE 3.1

PRELIMINARY CONCEPTUAL SITE MODEL

HWSA
Rickenbacker ANGB, Ohio

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Denver, Colorado

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A CSM qualitatively identifies how potential human and ecological receptors could come into contact with site-related contamination. A CSM is then used to assess data needs and guide data collection and analysis efforts. An *exposure assessment* involves estimating the type and magnitude of receptor exposures to COPCs that are present at or migrating from a site. COPCs are chemicals that are potentially site-related and the data for which are of sufficient quality for use in a quantitative risk assessment. A *risk assessment concentration* or *exposure-point concentration* is the highest concentration a potential receptor would reasonably be expected to contact. The 95-percent upper confidence limit (UCL) of the arithmetic mean for each COPC will be used as the exposure point concentration in the risk assessment process. The use of the 95-percent UCL for the exposure point concentration is consistent with Ohio EPA guidance (Ohio EPA, 1993b). The risk-based approach to remediation uses conservative quantitative models that account for the effects of fate and transport processes to estimate exposure-point concentrations. The probable effectiveness of natural attenuation processes and other innovative source removal technologies to reduce exposure-point concentrations will be determined using conservative quantitative models.

Chemical-specific remediation goals define the "acceptable" concentration of chemicals that can remain onsite following remediation and still meet remedial action objectives. These cleanup goals can either be risk-based or based on promulgated criteria. Remediation goals will be used to identify, select, and design an appropriate remedial alternative that will minimize or eliminate risks due to exposure to site-related contaminants. Remediation goals will be developed for the HWSA that are consistent with the desired/required level of risk reduction.

3.1.2 Contaminants of Potential Concern

The work detailed in this plan will address the specific chemical constituents that may drive potential risks and impact the final remedial design for the HWSA. As listed in Section 2.3.2, the soil and groundwater COPCs for the HWSA include fuel hydrocarbons (naphthalene and BTEX), CAHs (TCE, DCE, TCA, and vinyl chloride), metals, and polycyclic aromatic hydrocarbons (PAHs). Contaminants detected during subsequent assessment activities will be screened to identify any additional COPCs.

3.1.3 Fate and Transport Processes

The contaminant release mechanisms incorporated into the CSM shown in Figure 3.1 are as follow: (1) volatilization into the atmosphere; (2) previous direct release into soil; and (3) partitioning from residual soil contamination or light nonaqueous phase liquid (LNAPL) into groundwater. Subsequent to release, several processes affect the fate and transport of the COPCs in air, soil, and groundwater.

Release, fate, and transport processes associated with air included in this CSM are volatilization of contaminants from soil into air and subsequent transport through air dispersion. Contaminants possessing high vapor pressures are likely to volatilize into the atmosphere; however, the amount of paved ground and the proposed future use of the HWSA (i.e., installation of an asphalt and concrete taxiway) are expected to limit this release mechanism.

Release and migration processes of contaminants in soil include direct release and molecular diffusion of contaminants through unsaturated soil. Direct release in the HWSA is limited as removal of all USTs in the immediate vicinity of the HWSA was completed in 1994 and 1995. In general, migration of contaminants through soil via molecular diffusion is limited. A transport mechanism more likely to be operating at the HWSA is leaching of COPCs from soil into groundwater. Several soil COPCs may be relatively mobile and leach from contaminated soil into underlying groundwater and migrate as a dissolved plume.

The soil COPCs at the HWSA that have partitioned from contaminated unsaturated soil into groundwater are listed as groundwater COPCs (Section 2.3.2). In groundwater, the COPCs may migrate downgradient as a dissolved plume. Several mass transport mechanisms (volatilization, dispersion, diffusion, adsorption) and biodegradation can affect contaminant transport in groundwater.

Contamination also may be transported to groundwater by partitioning from LNAPL into groundwater. Once the contaminants reach groundwater, the water solubility of each chemical constituent governs how it partitions into groundwater. An octanol/water partitioning coefficient (K_{OW}) can be used to estimate the maximum concentration of a given organic COPC in groundwater as a result of partitioning from LNAPL into the aqueous phase. Available K_{OW} data support the observation that low-molecular-weight compounds, such as BTEX and CAHs, represent the COPCs that are most likely to impact groundwater quality, while higher-molecular-weight compounds such as PAHs are fairly insoluble in water. Metals also are expected to persist in site soils, rather than leaching into underlying groundwater. K_{OW} values also describe how well organic contaminants migrate in groundwater. Hydrophobic contaminants with high K_{OW} values tend to be retarded, due to sorption onto soil. PAHs and BTEX tend to sorb to soils more readily than CAHs, and therefore migrate more slowly in groundwater. Metals generally sorb very strongly to soils and are not likely to migrate great distances.

Groundwater discharge into and transport in surface water is not considered a complete exposure pathway at the HWSA primarily because no significant surface water bodies are located in or near the HWSA.

Of the COPCs, BTEX and CAHs are known to be naturally attenuated at numerous sites due to the effects of dispersion, diffusion, adsorption, and biodegradation. An investigation to determine whether significant natural attenuation is occurring at the HWSA was conducted in 1995 by Parsons ES (1997). Data suggest that natural attenuation is occurring at the HWSA. The effects of natural attenuation are discussed in Section 5 of the draft final amended closure/post-closure plan (Parsons ES, 1997). The long-term effectiveness of these processes at achieving and maintaining health-protective performance goals will be evaluated during the additional assessment activities to be completed at this site.

3.1.4 Potential Exposure Pathways

An exposure point is a location at which any potentially exposed receptor could come into contact with site-related contamination. On-base contaminated media will be

considered possible exposure points only for those base personnel who currently have access to the HWSA and for potential future on-base personnel and residents who may contact contaminated groundwater that migrates offsite. Potential exposure points initially included in this CSM include the HWSA and the environs downgradient from the site that are likely to be affected by contamination at or migrating from the source area. Several of these potential exposure points may be eliminated from the final evaluation should fate and transport data demonstrate that site-related contamination could not reach these locations (i.e., the exposure pathway is incomplete).

Potential exposure routes for current and potential human and ecological receptors identified in Figure 3.1 include inhalation of volatilized chemicals, dermal contact with soil and groundwater, incidental ingestion of soil and groundwater, and plant uptake. Using conservative exposure assumptions appropriate for the HWSA site, the only realistic human receptors that are likely to come in contact with impacted site media are onsite intrusive workers involved in either area maintenance or the installation of the proposed taxiway. The potential for inhalation of volatilized contaminants is minimal due to the amount of asphalt and concrete effectively capping the soil, and the lack of human or ecological receptors in the area. The potential for incidental dermal contact and ingestion of soil or groundwater is presently limited by pavement and the lack of intrusive work in the HWSA. Future work at the HWSA, including the installation of an additional taxiway could increase the probability of exposure via dermal contact and ingestion to humans. The chance of exposure to wildlife will only decrease with the addition of pavement. The potential exposure points, routes, and receptors will be further evaluated as a part of the additional assessment activities.

Plant uptake of contamination from soil and groundwater, and subsequent transport through food chain pathways is also not considered a significant fate process at HWSA. Due to the large amount of pavement at the HWSA, vegetation is limited. Groundwater is found at approximately 10 feet bgs, and is likely beyond the root zone of any local flora.

Prior to conducting a site-specific risk assessment that includes both residential and industrial scenarios, contact will be made with the Closure Unit of Ohio EPA's DHWM to determine if the residential scenario is necessary at this site. According to the guidance (OhioEPA, 1993b), DHWM "may consider use of an industrial scenario if deed restrictions are placed on the property or if expansion of the facility includes placement of a permanent structure directly over the unit."

3.2 PROPOSED SOIL REMEDIATION APPROACH

This section details the objectives and proposed additional assessment activities associated with COPCs in soil at the HWSA at Rickenbacker ANGB, Ohio.

3.2.1 Objectives

The objective of the soil remediation approach outlined in this work plan is to provide information necessary to implement and optimize the remedial or closure strategy that most cost-effectively reduces COPC concentrations in soil in the HWSA

below acceptable risk-based standards. The proposed approach to determine performance goals is described in Section 3.4.

3.2.2 Additional Assessment Activities

Available soil data for the HWSA are limited in nature and coverage. Consequently, to ensure that appropriate actions are taken at the HWSA to minimize any potential unacceptable risks associated with the soil contamination, additional sampling activities will be conducted. Further, data specific to optimizing a possible soil remediation approach (i.e., bioventing) will be collected. Based on the results of further soil and soil gas sampling to be performed, installation of a bioventing infrastructure (if necessary), and bioventing and air sparging treatability testing are currently proposed as part of the additional assessment activities. Section 4 of this work plan provides the basis approach and rationale for these soil-related activities.

3.3 PROPOSED GROUNDWATER REMEDIATION/CLOSURE APPROACH

This section summarizes the objectives and proposed additional assessment activities associated with COPCs in groundwater at the HWSA at Rickenbacker ANGB, Ohio.

3.3.1 Objectives

The objective of the groundwater remediation approach outlined in this work plan is to provide information necessary to implement and optimize the remedial or closure strategy that most cost-effectively reduces COPC concentrations in groundwater at the HWSA below acceptable risk-based standards. The proposed approach to determine performance goals is described in Section 3.4.

3.3.2 Natural Attenuation Processes

Remediation by natural attenuation refers to a management strategy that relies on natural attenuation mechanisms to remediate contaminants dissolved in groundwater and to control receptor exposure risks associated with contaminants in the subsurface. The USEPA Offices of Research and Development (ORD) and Solid Waste and Emergency Response (OSWER) define natural attenuation as:

The biodegradation, dispersion, sorption, volatilization, and/or chemical and biochemical stabilization of contaminants to effectively reduce contaminant toxicity, mobility, or volume to levels that are protective of human health and the ecosystem.

As suggested by this definition, mechanisms for natural attenuation of BTEX and CAHs include advection, dispersion, dilution from recharge, sorption, volatilization, abiotic chemical transformation, and biodegradation. Of these processes, biodegradation is the only mechanism working to transform contaminants into potentially innocuous byproducts. During biodegradation, indigenous microorganisms work to bring about a reduction in the total mass of contamination in the subsurface without the engineered addition of nutrients. Patterns and rates of natural attenuation can vary markedly from site to site depending on governing physical and chemical processes.

BTEX are biodegraded most rapidly under aerobic conditions, but can be degraded under anaerobic conditions. Metabolism of BTEX by microorganisms requires an electron donor (e.g., oxygen, ferric iron, nitrate, sulfate) as BTEX serve as the electron acceptors in this process. Therefore, BTEX degradation is generally coupled with a decrease of electron acceptor concentrations and an increase in degradation products (e.g., carbon dioxide, ferrous iron, sulfite, methane).

Chlorinated solvents can be transformed, directly or indirectly, by biological processes. CAHs may undergo biodegradation through three different pathways: use as an electron acceptor, use as an electron donor, or cometabolism, which is degradation resulting from exposure to a catalytic enzyme fortuitously produced during an unrelated process. At a given site, one or all of these processes may be operating, although at many sites the use of CAHs as electron acceptors appears to be the most important.

In a pristine aquifer, native organic carbon is utilized as an electron donor and dissolved oxygen is utilized first as the prime electron acceptor. Where anthropogenic carbon (e.g., fuel hydrocarbons or low-molecular-weight CAHs) is present, it also will be utilized as an electron donor. After the dissolved oxygen is consumed, anaerobic microorganisms typically use native electron acceptors (as available) in the following order of preference: nitrate, ferric iron oxyhydroxide, sulfate, and finally carbon dioxide. Evaluation of the distribution of these electron acceptors can provide evidence of where and how CAH biodegradation is occurring. In addition, because CAHs may be used as electron acceptors or electron donors (in competition with other acceptors or donors), maps showing the distribution of these compounds will also provide evidence on the types of biodegradation processes acting at a site.

Under anaerobic conditions, biodegradation of chlorinated solvents usually proceeds through a process called reductive dehalogenation. During this process, the halogenated hydrocarbon is used as an electron acceptor, not as a source of carbon, and a halogen atom is removed and replaced with a hydrogen atom. In general, reductive dehalogenation occurs by sequential dechlorination from PCE to TCE to DCE to vinyl chloride to ethene. Depending upon environmental conditions, this sequence may be interrupted, with other processes then acting upon the products. Reductive dehalogenation of chlorinated solvent compounds is associated with the accumulation of daughter products and an increase in chloride.

Reductive dehalogenation effects each of the chlorinated ethenes differently. PCE is the most susceptible of these compounds to reductive dehalogenation because it is the most oxidized. Conversely, vinyl chloride is the least susceptible to reductive dehalogenation because it is the least oxidized of these compounds. The rate of reductive dehalogenation also has been observed to decrease as the degree of chlorination decreases (Bouwer, 1994). Murray and Richardson (1993) have postulated that this rate decrease may explain the accumulation of vinyl chloride in PCE and TCE plumes that are undergoing reductive dechlorination (apparent at the HWSA).

Under aerobic conditions some CAH compounds can be utilized as the primary substrate (i.e., electron donor) in biologically mediated redox reactions (McCarty and Semprini, 1994). In this type of reaction, the facilitating microorganism obtains energy

and organic carbon from the degraded CAH. In contrast to reactions in which the CAH is used as an electron acceptor, only the least oxidized CAHs can be utilized as electron donors in biologically mediated redox reactions. McCarty and Semprini (1994) describe investigations in which vinyl chloride was shown to serve as a primary substrate. In addition, Bradley and Chapelle (1996) show evidence of mineralization of vinyl chloride under iron-reducing conditions so long as there is sufficient bioavailable iron (III). Murray and Richardson (1993) write that microorganisms are generally believed to be incapable of growth using TCE and PCE. Aerobic metabolism of vinyl chloride may be characterized by a loss of vinyl chloride mass, a decreasing molar ratio of vinyl chloride to other CAH compounds, and the presence of chloromethane.

As with BTEX, the driving force behind reduction/oxidation reactions resulting in CAH degradation is electron transfer. Although thermodynamically favorable, most of the reactions involved in CAH reduction and oxidation cannot proceed abiotically because of the lack of activation energy. Microorganisms are capable of providing the necessary activation energy; however, they will facilitate only those redox reactions that have a net yield of energy.

It has been determined that natural attenuation, specifically biodegradation, is occurring at the HWSA (Parsons ES, 1997); however, it is unknown whether vinyl chloride is accumulating in groundwater, which could potentially require the use of engineered treatment processes. These additional data are required to establish appropriate performance goals for groundwater and to develop a responsive comprehensive post-closure plan.

3.3.3 Engineered *In Situ* Treatment Approaches

If additional groundwater assessment activities, as described in Section 4 of this work plan, dictates, treatability studies will be conducted to examine the potential of two engineered *in situ* treatment technologies, air sparging and ORC® addition. These technologies are intended to reduce vinyl chloride and, if necessary, other CAH compounds at the "leading edge" of the contaminant plume. No engineered remediation designed to target other groundwater COPCs is planned at this time.

3.4 PERFORMANCE GOALS

Risk-based remediation is designed to combine natural physical, chemical, and biological processes with low-cost contaminant reduction technologies such as those discussed in Section 3.3, as necessary, to economically reduce potential risks to human health and the environment. To accurately determine if an engineered remediation process is necessary, and to optimize the design of a treatment system should conditions require, performance goals must be established. The additional assessment activities described in this work plan will be conducted to allow for a risk-based determination of site-specific target levels (SSTLs) or remedial/closure performance objectives. Preliminary COPCs have been identified in Section 2.3.2. Determination of SSTLs requires quantitative contaminant fate and transport analyses (calculations and modeling) according to site-specific hydrogeologic, contaminant, and potential receptor exposure pathway conditions. SSTLs are based on the outcome of a predictive exposure pathway analysis to evaluate current and potential future human health risks,

as well as short-term and long-term fate of the COPCs at the HWSA. A quantitative risk assessment will be completed following the completion of additional field assessment activities to help establish performance goals at the HWSA, per relevant Ohio EPA guidance (Ohio EPA, 1993b). This evaluation should result in a more focused remediation of those contaminants that may actually pose a risk to human health and the environment.

SECTION 4

PROPOSED ADDITIONAL FIELD ASSESSMENT ACTIVITIES

The purpose of this section is to describe the field assessment activities required to collect additional data necessary to implement/optimize the proposed remedial/closure strategy. Additional details on field sampling methodologies and laboratory analytical requirements/procedures are presented in Appendix A of this work plan.

4.1 GENERAL DATA NEEDS

The purpose of the proposed sampling and well installation activities is to provide further clarification on the nature and extent of soil and groundwater contamination that may warrant remediation prior to closure, and to provide the necessary wells and monitoring points for treatability tests (i.e., soil bioventing and groundwater oxygenation pilot tests). Field assessment activities will be conducted in the HWSA area and in the vicinity of ESMP-17S, as identified in Figure 4.1. The field assessment will be conducted in three phases. Phase I of the field assessment activities will involve geoprobe investigations of the soil and groundwater areas of interest. There are two primary objectives of this effort:

- Delineation of the extent of VOC soil contamination southeast of Building 560 (via soil gas surveying), and

- Delineation of groundwater contamination east/southeast of ESMP-17S.

The need for this information to optimize/implement proposed remedial/closure actions at the HWSA was specified in the 1997 closure/post-closure plan (Parsons ES, 1997), in response to Ohio EPA comments on previous drafts of the document.

Phase II of the field assessment activities will involve soil sampling, installation of bioventing infrastructure (if necessary), and installation of permanent groundwater monitoring/treatment points. Soil samples will be collected in areas shown to be characterized by elevated VOC concentrations during the Phase I soil gas survey. Soil samples will be collected during installation of at least one bioventing well and several vapor monitoring points. The bioventing well and vapor monitoring points will be used to field-test the effectiveness of the bioventing technology on residual VOC concentrations. The need for long-term operation of any bioventing system will be based on the outcome of the site-specific risk assessment to be prepared in accordance with Ohio EPA guidance (see Sections 3 and 5). Soil samples also will be collected during installation of any permanent groundwater monitoring wells/treatment points east/southeast (downgradient from) ESMP-17S. The purpose of these soil samples will be to characterize site hydrogeology in areas that may be subject to engineered

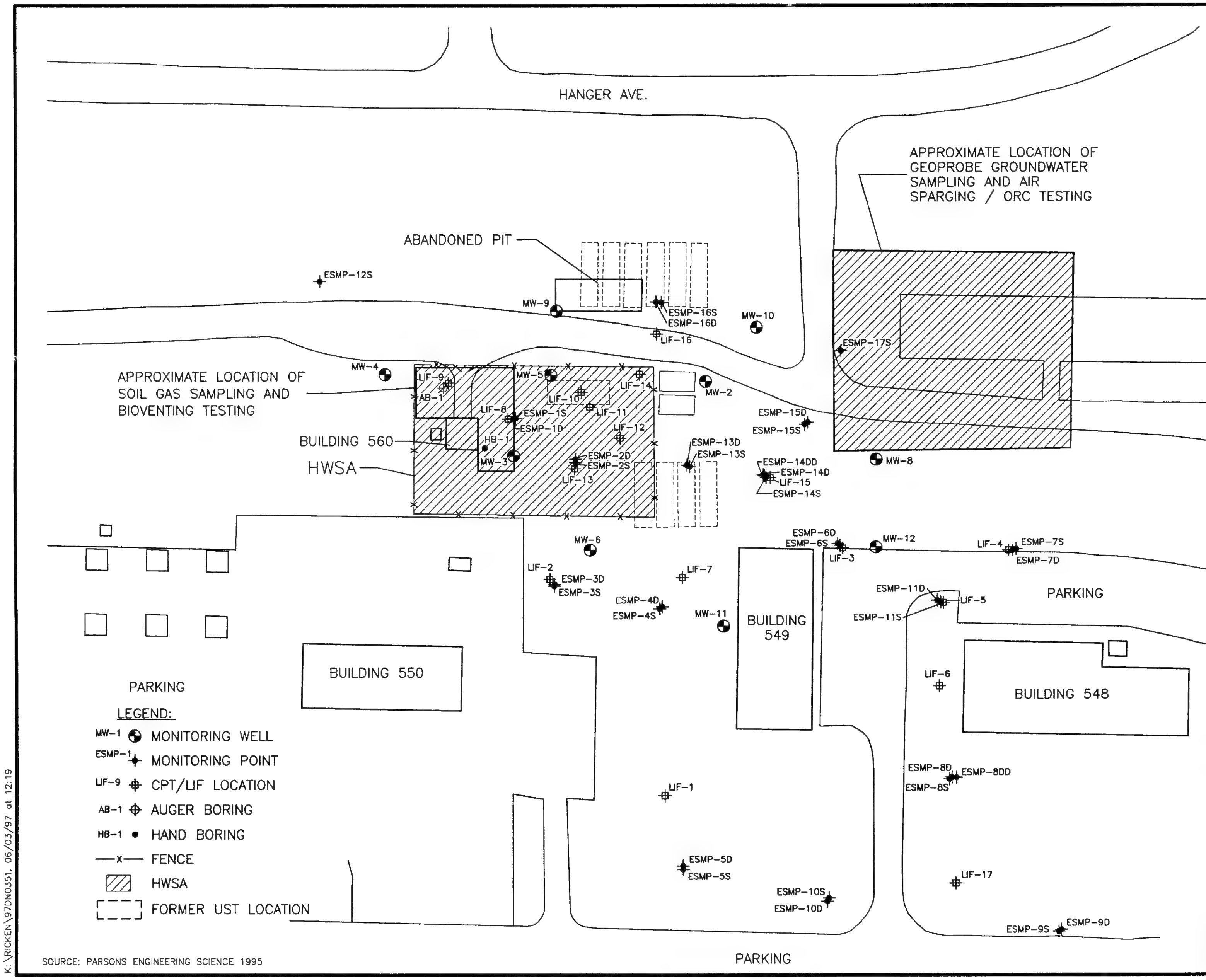

FIGURE 4.1

LOCATION OF ADDITIONAL ASSESSMENT AND TESTING AREA

HWSA
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treatment, and/or to provide baseline analytical information on residual contamination in both capillary fringe soils and possibly saturated soils.

Groundwater quality samples will also be collected from each of the newly installed permanent groundwater monitoring wells/treatment points. These data will be combined with groundwater analytical data collected from several other existing monitoring wells/points to confirm the nature and extent of groundwater contamination underlying the HWSA. These data will be used to support a site-specific risk assessment, as well as to optimize remedial/closure plans for groundwater. These data were identified as necessary to implement the proposed remedial/closure strategy presented in the 1997 closure/post-closure plan (Parsons ES, 1997).

Phase III includes treatability testing of (1) bioventing source area soils and (2) passive and forced oxygenation of groundwater. A bioventing pilot test will be completed in accordance with AFCEE protocols. The effectiveness of ORC® and air sparging also will be field tested in areas downgradient from ESMP-17S. Use of both of these types of remedial techniques is currently recommended in the 1997 closure/post-closure plan (Parsons ES, 1997). The nature and magnitude of any remediation activities conducted at the HWSA prior to securing closure will be quantitatively evaluated when these additional assessment data are available. One or both of these techniques may not need to be implemented at the site to achieve a risk assessment-based closure.

If it is determined that additional soil samples are needed for the quantitative risk assessment, a statistically-defensible sampling plan will be developed that adequately considers the horizontal and vertical extent of the COPCs in the soils.

4.2 ENVIRONMENTAL SAMPLING/MONITORING

4.2.1 Phase I - Source Area Soil Gas Sampling

Soil gas sampling will be conducted at several newly installed monitoring points. The soil gas sampling points will be installed using a Geoprobe. The soil gas sampling will be used to confirm and delineate the extent of VOC contamination previously detected in soil boring HB-1 (east of Building 560) and boring AB-1 (northeast of Building 560). Sampling will begin at the locations of HB-1 and AB-1, and will proceed outward in four directions from each point. Temporary soil vapor monitoring points will be installed at approximately 20 foot intervals. Samples collected from these points will be initially screened in the field for TVH. It is anticipated that approximately 10 to 20 soil gas sampling points will be installed. The exact number and locations of soil gas monitoring points will be determined in the field based on the screening results. The TVH analyzer used at the site will be capable of measuring hydrocarbon concentrations in the range of 1 to 20,000 parts per million, volume per volume (ppmv). The analyzer is also capable of distinguishing between methane and non-methane hydrocarbons. Gaseous concentrations of CO_2 and O_2 will also be measured in the field using an O_2/CO_2 analyzer.

All soil gas samples to be collected for fix-based analysis will be collected using 3-liter Tedlar® bags and a vacuum chamber. The soil gas samples will first be screened in the field for VOCs by attaching the O_2/CO_2 and TVH analyzers directly to the

Tedlar® bag. Based on field screening results, select locations will be resampled and compound-specific analyses will be conducted by a fixed-base laboratory using USEPA Method TO-14. Resampling will be conducted using new Tedlar® bags and 1-liter SUMMA® canisters.

4.2.2 Phase I - Screening Groundwater Sampling

Additional screening-level groundwater samples will be collected to the east and southeast of ESMP-17S to delineate the downgradient extent of groundwater contamination. These data will be used to guide the installation of permanent groundwater monitoring wells/treatment points. Groundwater samples will be collected using a Geoprobe with $3^1/_2$ foot stainless steel temporary well points. Groundwater samples will be collected from each discrete sand zone identified at each location and analyzed in the field using a portable GC. It is anticipated that two sand zones will be encountered. The upper zone will probably be present between a depth of approximately 14 to 18 feet bgs. The second zone will probably be encountered just above the gray silt and clay basal till, at a depth of approximately 21 to 25 feet bgs.

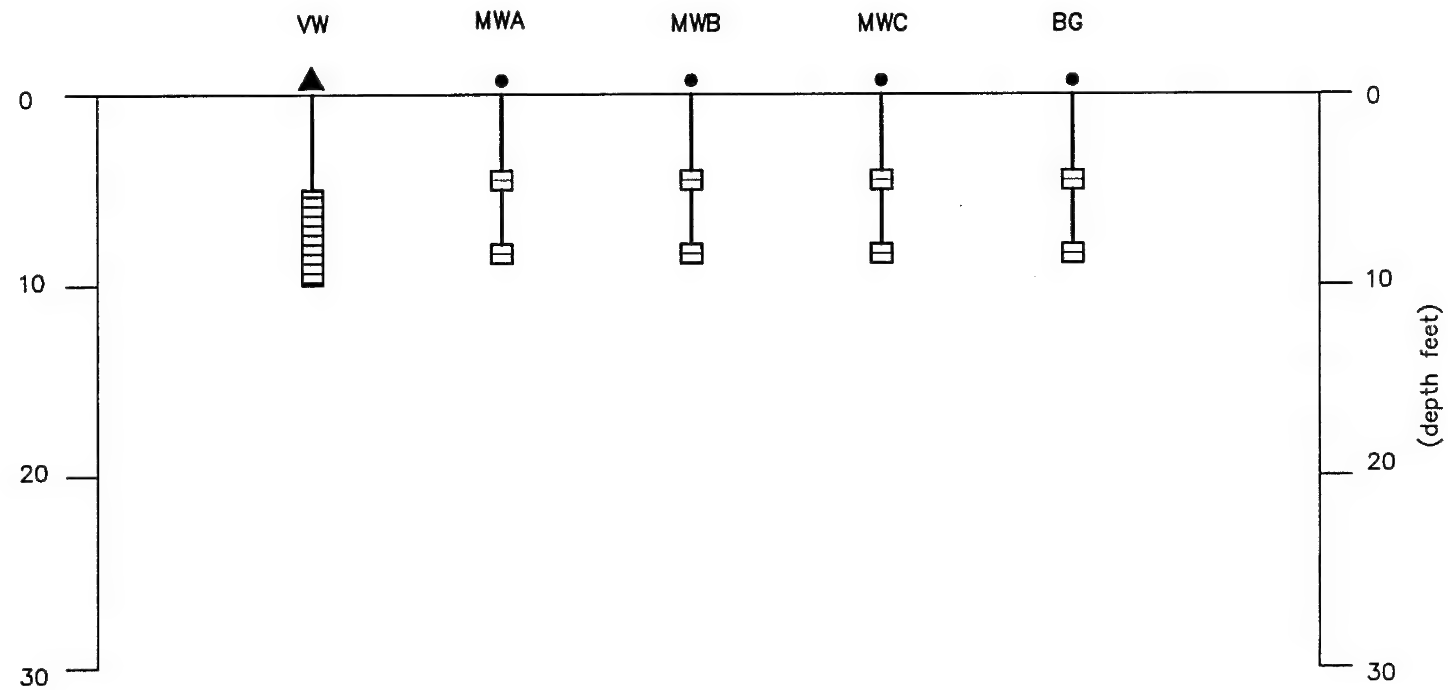
These temporary wells will be sampled using a peristaltic pump and Teflon-lined tubing. The samples will be analyzed for VOCs by EPA Method 8010 using a mobile laboratory. The exact number and locations of Geoprobe groundwater samples to be collected during Phase I will be determined in the field, based on the results from the mobile laboratory.

4.2.3 Phase II - Installation of Bioventing Infrastructure

One primary bioventing well (VW) will be installed in the impacted area southeast of Building 560. The exact location of well installation will be selected in the field to promote maximum VOC removal from impacted soils. The location of the primary VW will also depend on the location of onsite buildings and utilities.

Soil gas monitoring points MWA, MWB, and MWC will be installed within the source area at about 10, 20, and 30 feet from the VW, respectively (Figure 4.2). A background monitoring point (BG) will be installed near existing well MW-11 to monitor baseline conditions outside the area of influence of the bioventing system.

The primary bioventing well and permanent soil gas monitoring points will be drilled using Rotosonic drilling techniques. The VW and BG monitoring point will be continuously cored from a depth of 5 to 12 feet bgs to characterize in detail the zone to be treated. The VW casing will be screened from 5 to 10 feet bgs, which will serve to provide air to the vadose zone during bioventing operations. The casing will be completed with a 5-foot length of 2-inch diameter, Schedule 40, 0.04-inch slotted polyvinyl chloride (PVC) screen installed through an 8-inch-diameter drill string. The screened interval will extend approximately 2 feet below the groundwater surface to accommodate seasonal groundwater level changes. Flush-treated PVC casing and screen with no organic solvents or glues will be used. The filter pack will be clean, well-rounded silica sand with a No. 4 grain size and will be placed in the annular space to approximately 1 foot above the screened interval. A bentonite seal will be placed directly over the filter pack to produce an air-tight seal above the screened interval. The bentonite seal, consisting of granular bentonite, will be placed in 6-inch layers,



EXPLANATION

- ● MULTI–DEPTH MONITORING POINT
- ▲ VENT WELL
- BG BACKGROUND

FIGURE 4.2

CONCEPTUAL BIOVENTING SYSTEM

HWSA
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with each layer hydrated in place with potable water prior to the addition of subsequent layers. A complete seal is critical to prevent injected air from short-circuiting to the surface during the bioventing test. The casing string will be completed to surface with manifolding to the blower head. The penetrated lithologies will be logged in the field and drafted boring logs will be completed. Specifications for the proposed VW and soil gas monitoring points are shown in Figures 4.3 and 4.4.

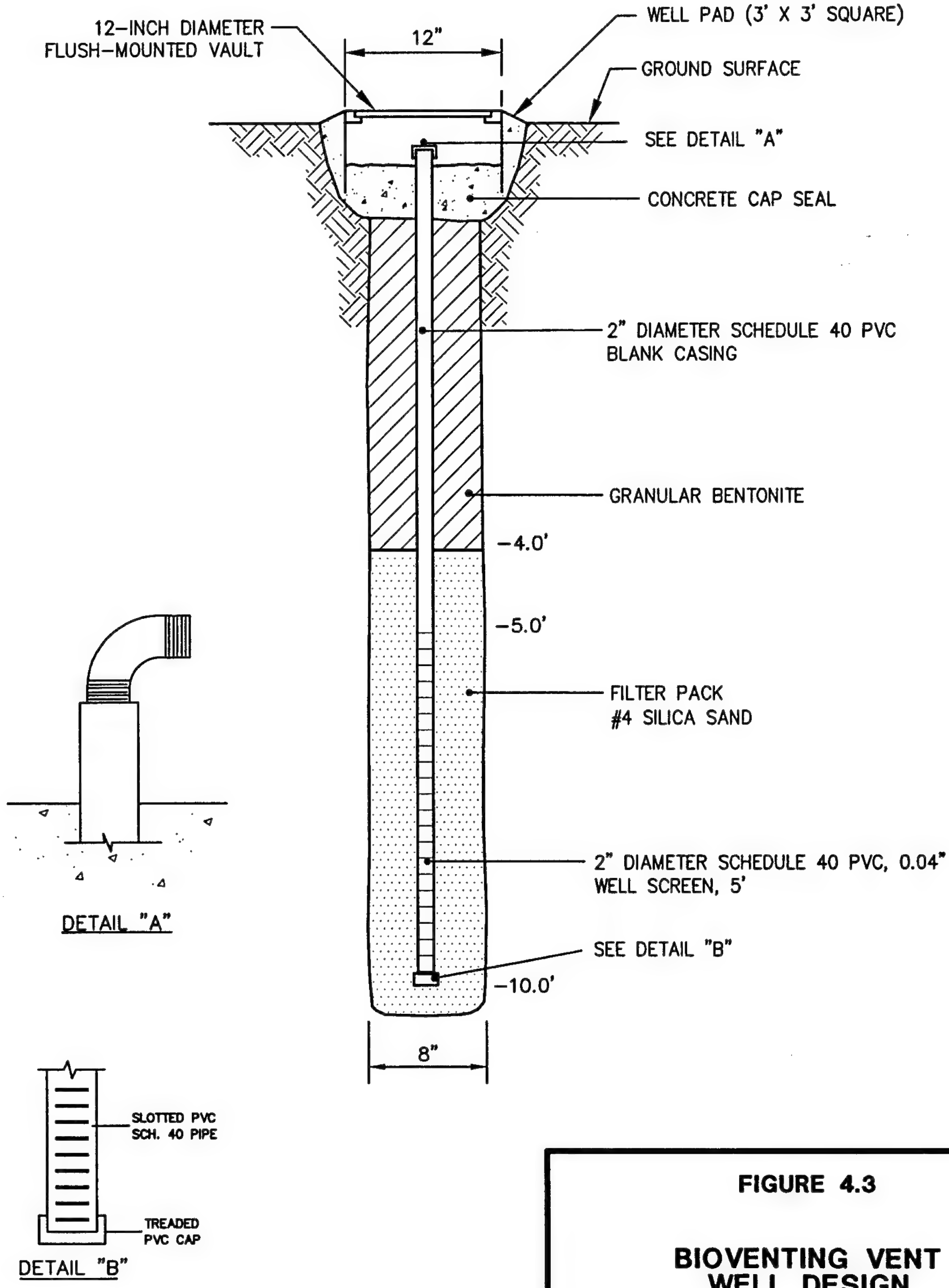
Each soil gas monitoring point (MWA, MWB, MWC, and BG) will be constructed through 8-inch-diameter Rotasonic drill pipe. Each monitoring point will be constructed with at least two vapor probes, each placed within a sand pack and separated from the other by a bentonite seal. Vapor probes, constructed of 6-inch-long sections of 1-inch-diameter PVC well screen, will be placed within a 1-foot layer of No. 5 silica sand. The probes will be connected to the surface with 0.25-inch Schedule 80 PVC risers. The annular spaces between the screened monitoring point intervals will be sealed with bentonite to isolate the monitoring intervals. The bentonite seals will consist of granular bentonite hydrated in place. The bentonite will be placed in 6-inch layers and hydrated with potable water prior to placement of subsequent layers to assure complete saturation of the bentonite. Additional details on VW and monitoring point construction are presented in Section 4 of the bioventing protocol document (Hinchee *et al.*, 1992).

One Type K thermocouple (Omega Engineering, Inc., Stamford, Connecticut) will be placed in one of the system monitoring points. The thermocouple will be labeled according to the center of the depth interval in which it will be placed. The thermocouple will be used to monitor *in situ* soil temperature, as temperature affects microbial respiration rates.

Soil sampling will be performed continuously for each borehole from approximately 2 feet bgs to total depth. Based on field screening results, soil samples from the most contaminated intervals will be submitted for laboratory analysis. At least one soil sample will be collected from each VW and monitoring point borehole for laboratory analysis of total petroleum hydrocarbon (TPH; gasoline and diesel range), VOCs, SVOCs, TAL metals, and moisture. In addition, samples from the test and background areas will be submitted for laboratory analysis of ammonia nitrogen, ortho-phosphate, pH, microbial enumerations, and bulk density.

4.2.4 Phase II - Installation of Additional Monitoring Wells

Additional monitoring wells/points will be installed along the "leading edge" of the chlorinated VOC contaminant plume in the area east/southeast of ESMP-17S (Figure 2.16) and along the leading edge of the BTEX plume in the area east of ESMP-16S (Figure 2.17). These wells/points will be used to monitor the plumes during quarterly monitoring events, and to evaluate the results of the groundwater oxygenation treatability testing near ESMP-17S (Figure 4.1). The well/point locations and depths will be determined in the field based on the results of the Geoprobe sampling and mobile laboratory analysis. It is anticipated that a minimum of two additional groundwater monitoring wells will be installed in each of these locations. Wells will be installed downgradient from each of these locations and additional monitoring wells may be required if the leading edge of a plume is wider than anticipated or if multiple contaminated zones are encountered. Additional monitoring wells also will be installed



NOTE: NOT TO SCALE

FIGURE 4.3

BIOVENTING VENT WELL DESIGN

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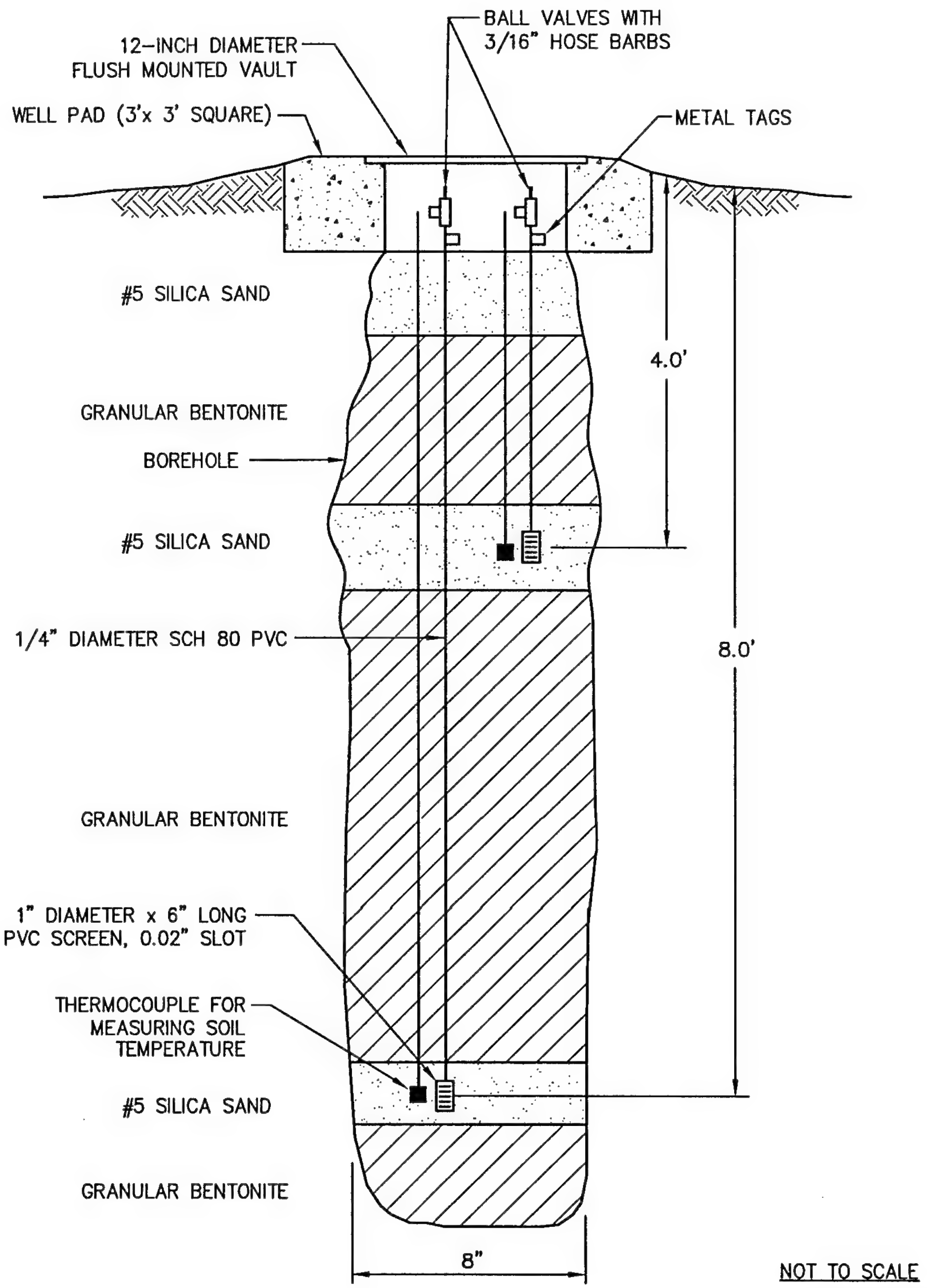

FIGURE 4.4

BIOVENTING MONITORING POINT DESIGN

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for the post-closure monitoring system at the HWSA. These wells are not included in the scope of this investigation. However, some of the additional wells installed as part of this investigation may be utilized for the post-closure monitoring system.

The monitoring wells will be installed using Rotosonic drilling techniques to obtain a continuous core sample from the borehole and to minimize the generation of soil cuttings requiring disposal. The wells will be constructed of 2-inch-diameter PVC casing and screen. The length of the screen sections will be determined by the thickness of the sand seams encountered. A well will not be screened across more than one sand zone. Following installation and development of the additional monitoring wells, the wells will be sampled. The samples will be analyzed by an offsite laboratory for VOCs.

4.2.5 Phase II - Installation of Groundwater Oxygenation Treatment Wells

One primary treatment point or sparge well (SW) and three monitoring wells will be installed in the vicinity of well ESMP-17S. A conceptual sparging system layout is presented in Figure 4.5. The monitoring points for the oxygenation system will be positioned approximately 5, 10, and 15 feet from SW, respectively, and perpendicular to the groundwater flow direction.

Each oxygenation treatment point will be drilled using Rotosonic drilling techniques. The points will be continuously cored to characterize in detail the zone to be treated. The penetrated lithologies will be logged in the field and draft boring logs completed. The boring for the primary treatment well (SW) will then be placed with an 8-inch-diameter drill string to allow for placement of two strings of casing. The upper casing string will be 1-inch in diameter and screened from 7.5 to 8 feet so that contaminant gas concentrations in the vadose zone can be monitored during operation. The second casing string will be 2-inches in diameter and screened from 15 to 17 feet and will serve to supply sparge air during the air sparge investigation. The upper and lower casing strings will be completed separately to the surface with manifolding to the blower head.

The upper casing string will be completed with a 6-inch length of 1-inch diameter, 0.02-inch slotted PVC screen connected to a 0.25-inch riser. The lower casing string will be completed with a 2-foot length of 2-inch diameter, 0.02-inch slotted PVC screen. A bentonite seal will be placed above the upper screened interval and between the upper and lower screens to prevent air flow vertically within the well bore sand pack. The specifications of the completed treatment point (SW) and associated monitoring points wells are presented in Figures 4.6 and 4.7.

Each sparge monitoring point will be constructed with three strings of casings set through 8-inch-diameter drill pipe. The upper casing string will be 1-inch in diameter and screened from 7.5 to 8 feet bgs, so that contaminant gas concentrations in the vadose zone can be monitored during operation. The second and third casing strings will be 2-inches in diameter and screened from 15 to 15.5 feet bgs and 16.5 to 17 feet bgs, respectively. These points will serve to monitor dissolved oxygen concentrations in the groundwater. The objective of this well screen placement is to observe groundwater fluctuations and dissolved oxygen concentrations at the top and bottom of the treatment zone during the air sparge study. The water table is estimated at a depth

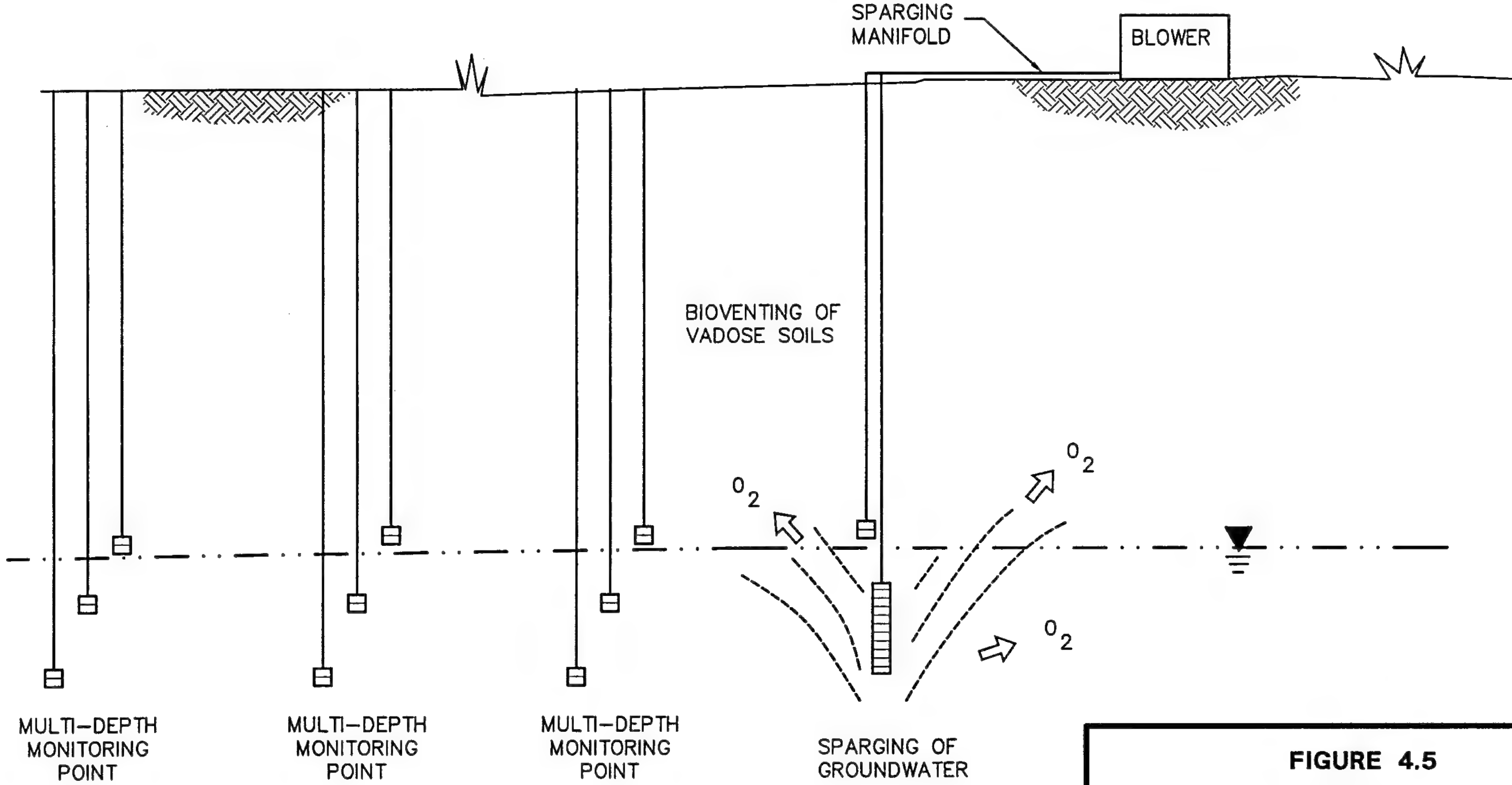

FIGURE 4.5

CONCEPTUAL SPARGING SYSTEM

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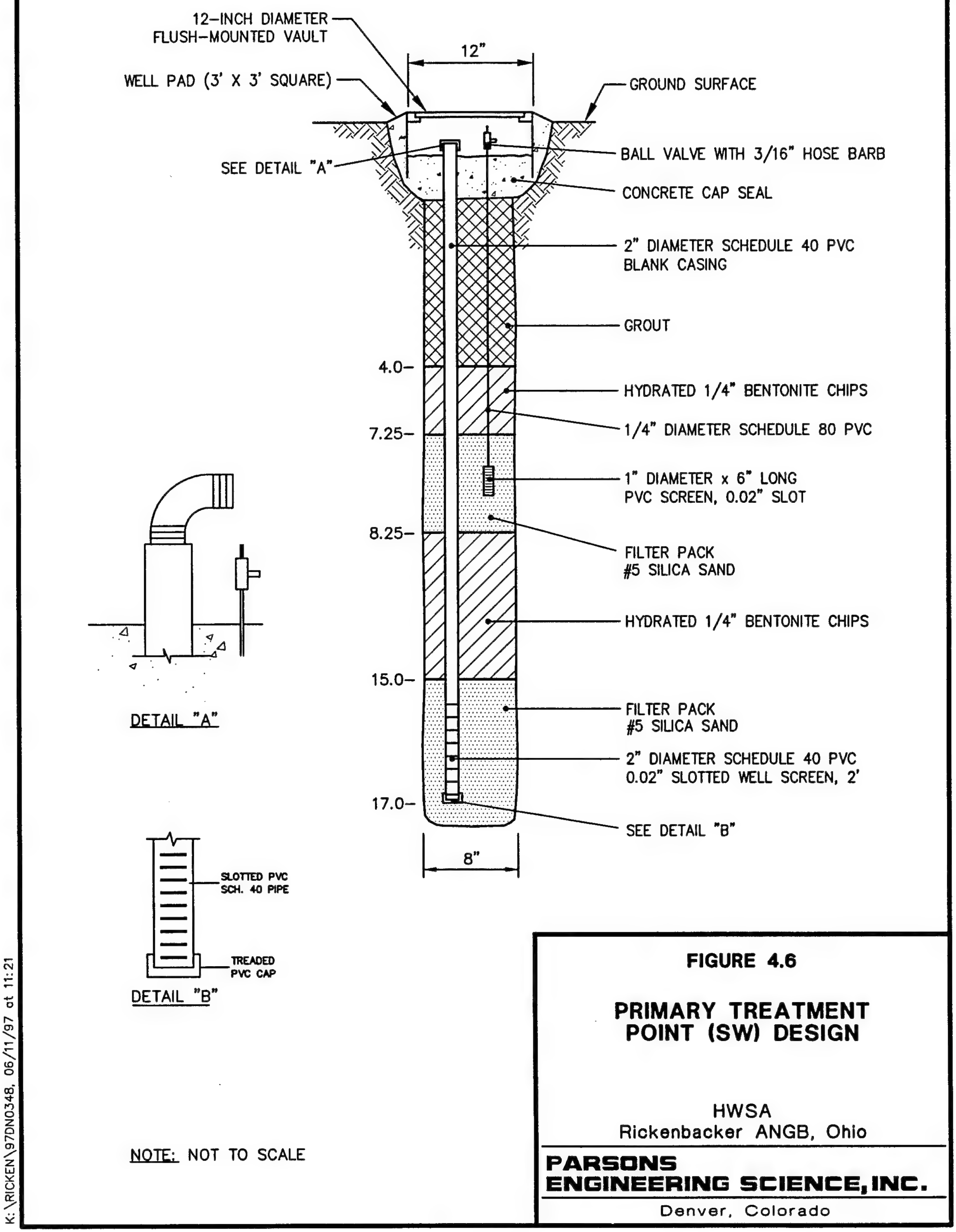

FIGURE 4.6

PRIMARY TREATMENT POINT (SW) DESIGN

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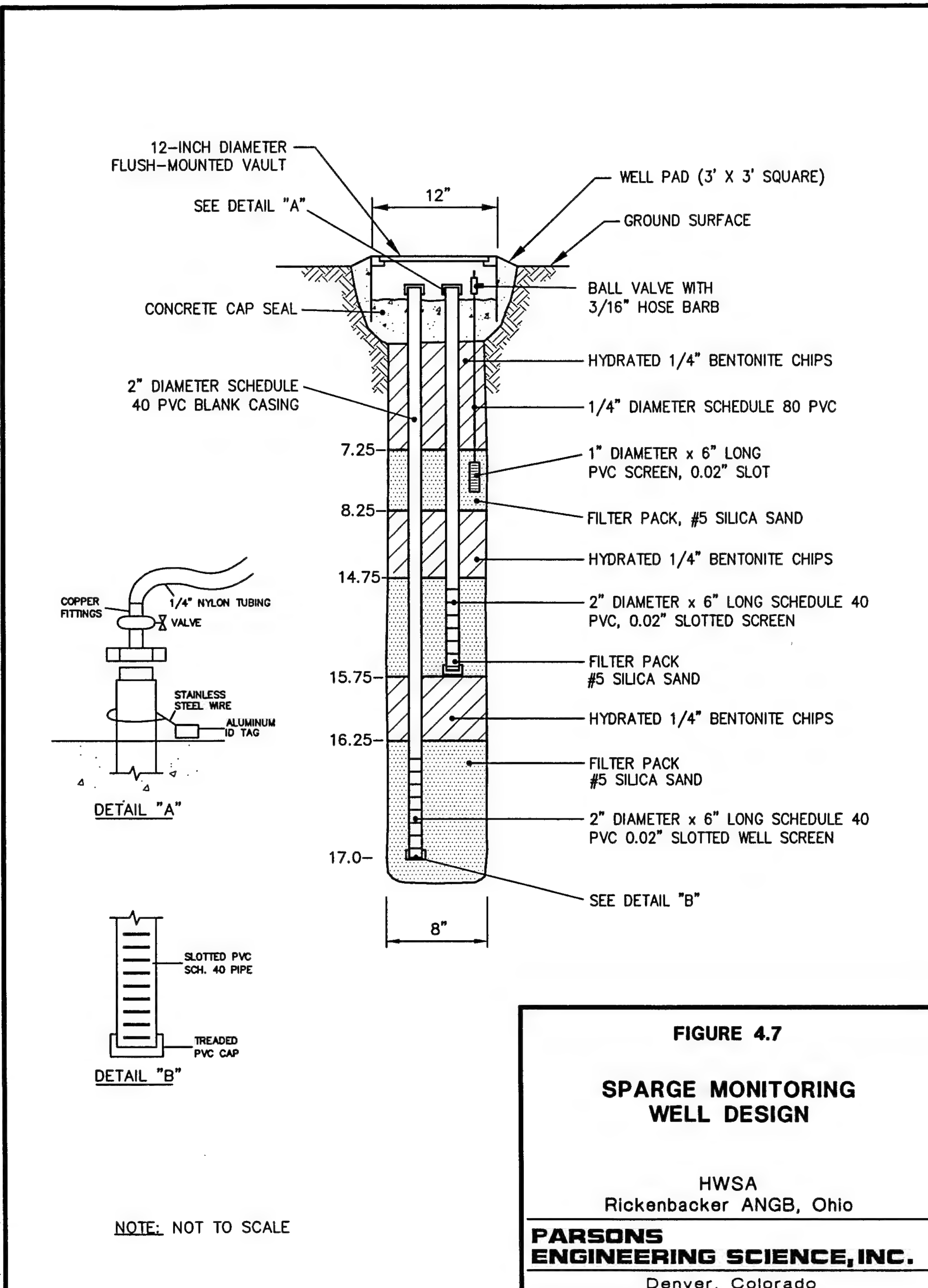

FIGURE 4.7

SPARGE MONITORING WELL DESIGN

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of about 10 feet bgs. Subsurface beds will be correlated between the SW and associated monitoring wells to allow bedding and lithology effects to be considered when evaluating treatability results. A bentonite seal will be placed above the upper screened interval and between the screens to prevent air flow vertically within the well bore sand pack.

A significant cost savings will be recognized during bioventing and groundwater oxygenation tests by using multiple well completions within the same borehole for the injection and monitoring wells. The proposed design of the SW and the monitoring points will allow for combined or separate operation of the bioventing and air sparging systems. If the deeper sand and gravel zone at a depth of approximately 21 to 24 feet bgs is determined to be contaminated during the Geoprobe investigation, the SW will be screened across both zones and additional monitoring points will be screened in the deeper zone.

One soil sample will be collected from each screen interval and tested for total iron, ammoniacal nitrogen, ortho-phosphate, soil moisture, pH, VOCs, and microbial enumerations.

4.2.6 Additional Soil Sampling

Critical review of existing soil data may result in a need for additional samples at the HWSA. Data to be reviewed will include not only historical results, but also results from soil samples collected during Phase II and Phase III, as previously described.

If it is determined that additional soil samples are needed, a statistically-defensible sampling plan will be developed that follows the main principles of probability-based sampling. The five principles for designing and effective sampling plan include:

- Randomized design;
- Good coverage;
- Representative samples;
- Site-specific knowledge; and
- Statistical constraints.

Randomization will be used to determine the specific locations of the samples at the site. This principle is the fundamental requirement of statistical inference and is accomplished through the use of computer-generated pseudo-random numbers. Various applications of random sampling will be considered based on the specific goals of the sampling and site-specific knowledge. Some examples of random sampling strategies include (1) stratified random sampling that can more efficiently allocate money and resources (e.g., target a known source area), (2) Latin hypercube sampling that can help maximize the aerial "coverage" of the sampling program, given a limited number of samples to be taken, and (3) adaptive sampling (e.g., sequential sampling) that can be used to allow the sampling strategy to evolve as more information is gathered. One

use of adaptive sampling is to minimize the cost of delineating hot-spot type contamination.

Coverage refers to determining the minimum number of samples to adequately cover the spatial or temporal extents of the facility and operations. This principle will be used to divide the sampling space into discrete, non-overlapping intervals to represent the true distribution of soil contaminant concentrations.

Representiveness describes how appropriate the collection of samples are in reflecting the true nature of the process under study. The sample design should strive to achieve the most representative samples possible. Site-specific knowledge and the goals of the sampling program help define what is representative.

Finally, the constraints of anticipated statistical methods should be considered in the sampling design. Comparisons to background data, for example, involving the upper tail of the distribution require many more samples than tests of central tendency. What is commonly called a "hot-measurement" screen, used to identify the highest potential site-related concentrations, may require a significant number of background samples to achieve a "sensitive" enough statistical test. However, it may be applicable during risk assessment activities to compare the *average* site data from an exposure interval of interest to background data which would likely require a much smaller combined sample size for both site and background data.

As discussed in Ohio EPA guidance (Ohio EPA, 1993a), soil sample locations must be adequately determined so that the full horizontal and vertical extent for all COPCs are considered. If additional sampling is deemed necessary, relevant guidance (Ohio EPA, 1993a; Ohio EPA, 1993b) will be considered in the sampling design stage.

4.3 INITIAL TREATABILITY TESTING

4.3.1 Bioventing

During Phase III activities soil gas sampling, VW radius of influence, air permeability, and *in situ* respiration testing will be performed.

4.3.1.1 Soil Gas Sampling

Soil gas samples will be collected from the VW and monitoring points for field and laboratory analyses. Soil gas from the VW and all monitoring point screened intervals will be analyzed using direct-reading field instruments for oxygen, carbon dioxide, and total volatile hydrocarbons (TVH). Soil gas samples from the five most contaminated locations will be collected in 1-liter SUMMA® canisters in accordance with the *Bioventing Field Sampling Plan* (Engineering-Science, Inc., 1992) and submitted to Air Toxics, Inc. for laboratory analysis of VOCs by EPA Method TO-14. These soil gas samples will be used to predict potential air emissions, to determine reductions in VOC concentrations during the long-term operation of the bioventing system, and to detect any migration of these vapors from the source area.

4.3.1.2 Radius of Influence and Air Permeability Testing

The VW radius of influence and air permeability testing will be performed using a positive displacement blower, Magnehelic pressure gauges (Dwyer Instruments Inc., Michigan City, Indiana), and a GA-90 gas analyzer (Landtec Instruments Co., Commerce, California). TPH will be measured using a photo-ionization detector (PID). An inline ORBO carbon filter (Supelco Park, Bellefonte, Pennsylvania) will be used to filter the air stream for the GA-90 gas analyzer.

The inlet side of the blower will include an air filter, a blower producing up to 75 cubic feet per minute (cfm) and an air flow indicator calibrated for site operating conditions. The outlet side of the blower will be connected to the primary bioventing well using valves and pipe fittings (Figure 4.8). Major system components will be as follows:

<u>Main Line:</u>

- 2-inch check valve - prevent backflow in case of system shutdown,
- 2-inch ball valve - main airflow shutoff,
- 1-inch flow indicator (FI) monitoring port - valve from which the flow is measured,
- 1-inch discharge valve - temperature indicator (TI) and air flow control through main system, and
- 1-inch pressure relief valve (PSV) - limits the build up of pressure in the system to a maximum of 10 pounds per square inch (psi).

<u>Well Casing:</u>

- 2-inch ball valve - casing flow control/flow shutoff, and
- ½-inch sampling port - "quick connect fitting," sampling port for O_2, CO_2, CH_4, helium gases, VOCs, TPH, and pressure .

The objective of the air permeability test is to determine the extent of the subsurface that can be oxygenated using the air injection VW. Results from this test will be used to determine well spacing, air injection rates, and injection pressure for long-term system operation and full-scale bioventing system design, if applicable.

Prior to initiating the test, baseline concentrations of oxygen, carbon dioxide, and TVH will be measured in soil gas from the VW and each monitoring point screened interval (Section 4.3.1.1). Air will be injected into the VW using the blower unit, and pressure response will be measured at each monitoring point with differential pressure gauges to determine the region influenced by the unit. The permeability test will be performed at various flow rates to determine the optimum rate for the full-scale system. Oxygen also will be monitored in the monitoring points to ascertain whether oxygen

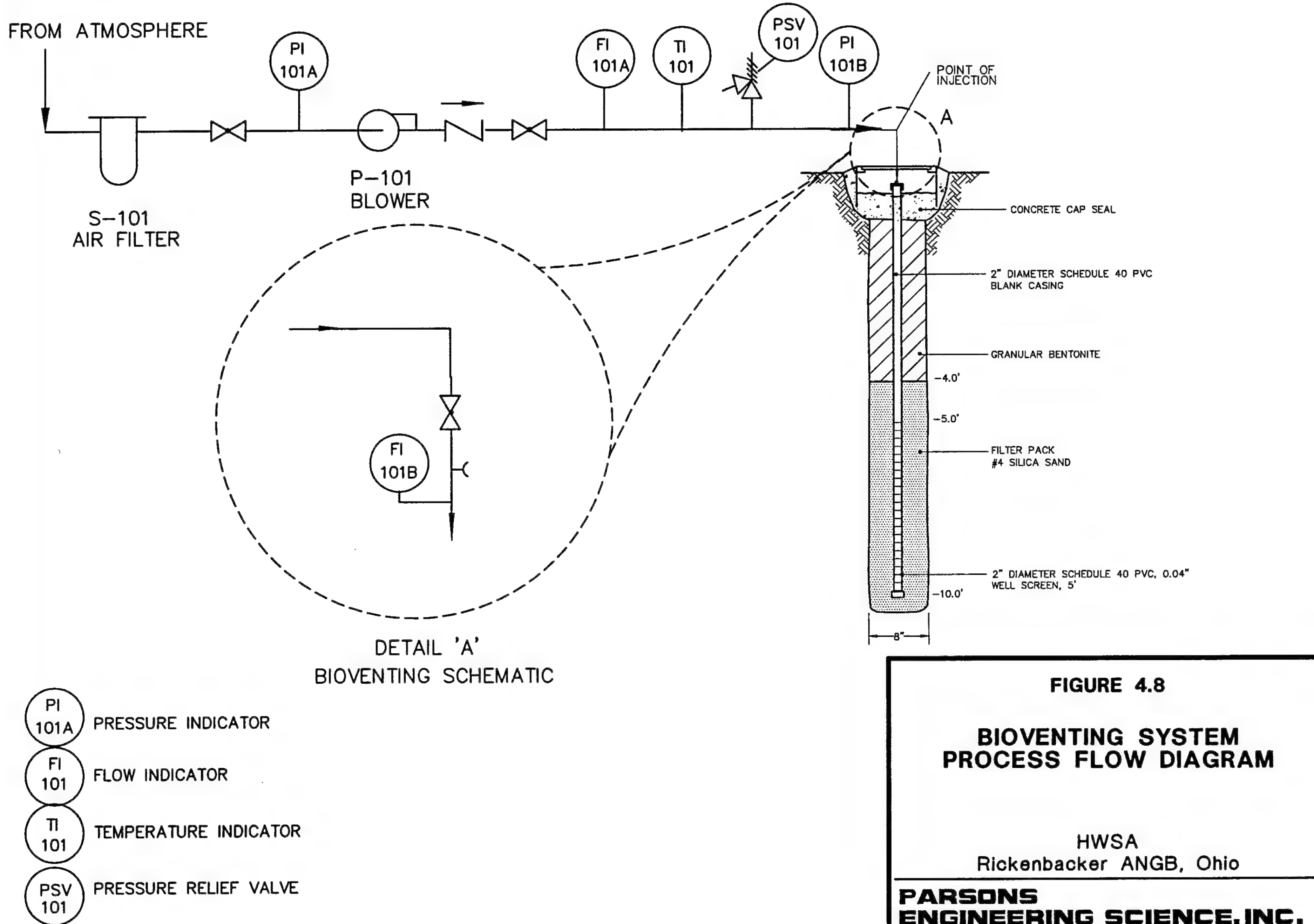

FIGURE 4.8

BIOVENTING SYSTEM PROCESS FLOW DIAGRAM

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levels in the soil increase as the result of air injection. One air permeability test lasting approximately 24 hours will be performed.

Ambient air quality monitoring will be conducted during the air permeability test to determine if air injection into the soil will displace VOCs into the atmosphere. Air quality monitoring will be conducted across the pilot testing area on an hourly basis, at a minimum, during the first four hours of the air permeability test. If VOCs are detected in ambient air at concentrations exceeding safety thresholds, the test will be discontinued. If VOCs are detected at lower concentrations, monitoring will continue until the detections dissipate. If VOCs persist in ambient air, corrective action (i.e. decreasing the air injection flow rate, identifying and blocking preferential flow channels to the surface) will be taken. If these corrective actions are performed and VOCs still persist in ambient air, the test will be discontinued and an alternative remedial approach will be recommended. Past experience at other bioventing sites has shown that VOCs are rarely driven into the atmosphere at detectable concentrations during bioventing operations.

4.3.1.3 *In Situ* Respiration Test

The objective of the *in situ* respiration test is to determine the rate at which soil bacteria degrade petroleum hydrocarbons. Respiration tests will be performed at selected monitoring points where bacterial biodegradation of hydrocarbons is indicated by depleted oxygen concentrations and elevated carbon dioxide concentrations (>5%) in the soil gas. Using 1-cubic-foot-per-minute (cfm) pumps, air will be injected into approximately four monitoring point depth intervals containing low levels of oxygen. A 20-hour air injection period will be used to oxygenate contaminated soils in the vicinity of the monitoring point intervals. At the end of the 20-hour air injection period, the air supply will be cut off, and oxygen, carbon dioxide, and TVH concentrations will be monitored for the following 48 to 72 hours. The decline in oxygen and increase in carbon dioxide concentrations over time will be used to estimate rates of bacterial degradation of fuel residuals. Helium also will be injected into the selected monitoring point screened intervals to determine the effectiveness of the bentonite seals. Additional details on the *in situ* respiration test are found in Section 5.7 of the protocol document (Hinchee *et al.*, 1992).

4.3.1.4 Oxygen Utilization

Oxygen utilization rates will be determined from the data obtained during respiration testing. The rates will be calculated as the percent change in O_2 over time. A zero-order respiration rate is typical at most sites. A stoichiometric relationship for the oxidation of the hydrocarbon will be used to estimate biodegradation rates of hydrocarbon from the oxygen utilization rates. Hexane will be used as the representative hydrocarbon, and the following stoichiometric relationship will be used to determine degradation rates:

$$C_6H_{14} + 9.5\ O_2 \dashrightarrow 6\ CO_2 + 7\ H_2O \quad \text{[Eq. 1]}$$

Based on the utilization rates (change of oxygen [percent] per day), the biodegradation rate in terms of milligrams of hexane-equivalent per kilograms of soil per day will be estimated using the following equation:

$$KB = -K_o\ A\ D_o\ C/100 \quad [Eq.\ 2]$$

where:

KB = Biodegradation rate (milligrams per kilogram per day [mg/kg/day])

K_o = Oxygen utilization rate (percent per day)

A = Volume of air/kg of soil (liters per kilogram [L/kg])

D_o = Density of oxygen gas (milligrams per liter [mg/L])

C = Mass ratio of hydrocarbon to oxygen required for mineralization.

Based on the following assumptions, values for A, D_o, and C can be calculated and substituted into Equation 2.

- Porosity of 0.3 (the air-filled porosity, which can range from 0.0 to 0.6, depends on the site soils and varies with moisture content in any given soil),
- Soil bulk density of 2,450 kilograms per cubic meter (kg/m3),
- D_o oxygen density of 1,330 mg/L (varies with temperature, altitude, and atmospheric pressure), and
- C, hydrocarbon-to-oxygen ratio of 1/3.5 from the above equation for hexane.

Based on the above assumed porosity and bulk density, the term A, volume of air per milligram of soil becomes 300/2,450 = 0.12. The resulting equation is:

$$KB = -(K_o)(0.12)(1330)(1/3.5)/100 = -0.5\ K_o \quad [Eq.\ 3]$$

4.3.2 Air Sparging

Air sparging is being conducted to evaluate the effectiveness of this technology to provide an oxygenated barrier to downgradient migration of chlorinated solvent reductive dechlorination products (i.e., vinyl chloride). Two air sparging pilot tests, one continuous air injection test and one pulsed air injection test, will be conducted near well ESMP-17 to confirm the effectiveness of the technology.

The first test will be a 24-hour test with continuous air injection utilizing the lower SW well casing for injection and the upper SW casing and the three sparge monitoring wells for observation. The purpose of the continuous test will be to evaluate if and how the aquifer will respond to the injection and will act as a baseline with which to compare other air sparging techniques.

Following the recovery of the continuous test, a 24-hour pulsed test will be conducted in the same manner as the continuous test except that air will be injected continuously for a period of approximately two hours, shut down for approximately two hours, then continue the cycle for the remainder of the test. A pulsed scenario will be evaluated because it may not be necessary for a full-scale sparge system to operate

continuously to be effective in intercepting the contaminated groundwater. In addition, a pulsed scenario could reduce capital and operation and maintenance (O&M) costs by allowing for the use of a smaller compressor for a full-scale system.

Prior to startup of each test, background and baseline water level and dissolved oxygen measurements will be collected in the lower SW casing and the two lower monitoring point screened intervals. Dissolved oxygen levels will be monitored *in situ* with a downhole YSI dissolved oxygen probe with data logger to measure the sparge radius of influence. Water levels will be monitored for mounding effects using pressure transducers and a Hermit data logger. Following the test, the recovery of the saturated zone will be monitored in the same manner.

Once these baseline measurements have been completed, air and sulfur hexafluoride (SF_6) will be injected into SW for a maximum period of 24 hours. Air will be injected into SW for the constant air injection test at approximately 5 to 10 cfm. Following initial pressurization of the SW casing string the injection rate is anticipated to decrease. The SW lower casing string pressure will be maintained at approximately 10 psi throughout the test period, assuming a water column of approximately 15 feet above the sparge injection point. The anticipated flow rate and pressure are subject to modification based on actual field conditions. The flow rate, pressure, and SF_6 concentrations will be monitored in the SW for changes that could possibly indicate short circuiting along the side of the well or even obstructions in or around the sparge well. SF_6 will also be monitored in the observation wells and results will be used to help evaluate the radius of influence. A valve will allow adjustment of pressure and flow rate, while a check valve will prevent backflow of air and water from the sparge well into the blower system. Figure 4.9 represents a conceptual air sparging process flow diagram.

The pulsed test will be conducted in the same manner as the continuous test except that air will be injected using a 2 hour on, 2 hour off cycle following an initial continuous injection period of 4 hours.

Increases in VOC concentrations in the vadose zone will be monitored in the upper SW casing and upper screened interval of the three monitoring wells. One soil gas sample from the upper SW and the three monitoring wells will be collected and analyzed for VOC, TPH, carbon dioxide, oxygen, methane, and SF_6. Parameters which will be monitored during the test include water levels, dissolved oxygen concentrations, SF_6 concentrations in the vadose zone, rates of air injection, air pressure at SW, the occurrence of bubbling, and the recovery of the saturated zone after discontinuation of air injection.

4.3.3 Oxygen Release Compounds

ORC® also may be evaluated following the air sparging and bioventing investigations to determine the cost effectiveness and feasibility of utilizing a solid-phase oxygen source rather than air injection. ORC® application will promote biodegradation of the contaminants rather than stripping/biodegradation accomplished with air sparging.

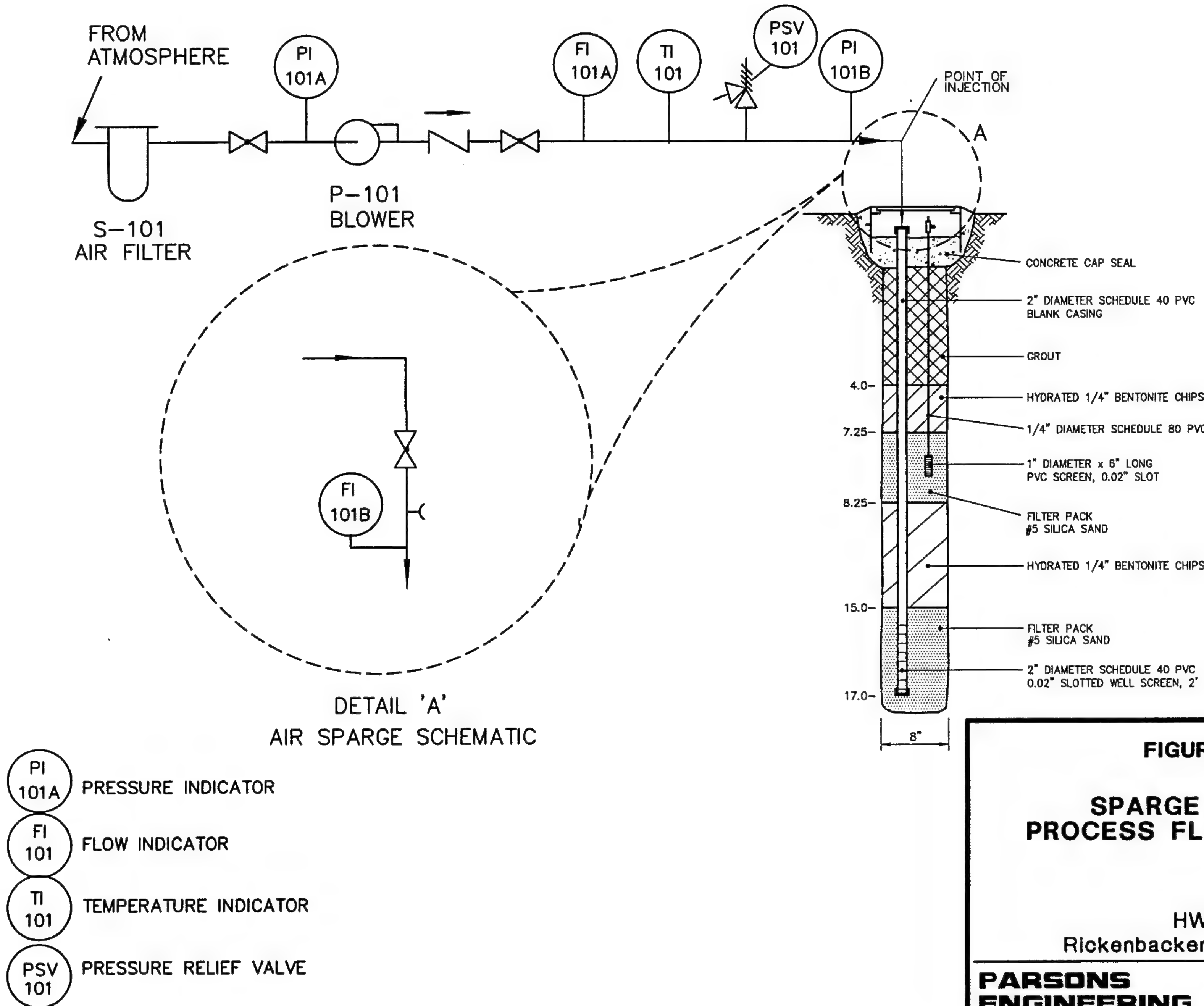

FIGURE 4.9

SPARGE SYSTEM PROCESS FLOW DIAGRAM

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ORC® is a solid-phase magnesium peroxide powder contained in an inert filter sock that releases oxygen when in contact with water. ORC® has been used at many sites across the United States to enhance the bioremediation of dissolved-hydrocarbon contamination by supplying dissolved oxygen to groundwater aquifers. When in contact with water, ORC® releases oxygen by rehydrating as shown in the following equation:

$$MgO_2 + H_2O = 1/2O_2 + Mg(OH)_2$$

The products from the reaction are oxygen and magnesium hydroxide, which do not adversely affect the environment. ORC® socks enhance aerobic bioremediation by releasing dissolved oxygen for approximately 6 months. When the oxygen exhausts, the remaining ORC® material is inert magnesium hydroxide. The socks are then removed from the well and replaced, if necessary.

ORC® socks will be attached to a stainless-steel cord or high-durability rope and lowered into the well. Upon reaching the desired depth, the stainless-steel cord or high-durability rope will be secured to the well cap and well head.

A radius of influence test will be completed to determine the distance oxygen will travel within the aquifer. The solid-phase peroxide sources will be placed into the lower SW casing and downgradient migration of oxygen and the nutrients will be monitored in monitoring wells. The need for placement of two additional wells downgradient of SW will be determined during the evaluation of the radius of influence data.

Prior to ORC® placement, dissolved iron concentrations in groundwater will be measured to evaluate the potential for precipitation of iron hydroxides and clogging of the test well(s). Based on the dissolved iron levels in the test area, ORC® placement may, or may not, be pursued. If ORC® placement and testing is performed, monitoring will be completed using downhole monitoring probes and field kits. Once baseline conditions have been established and ORC® installed, continuous monitoring will be conducted throughout a 10-day period. Depending on the field results, the frequency and length of monitoring may be adjusted.

Field measurements of magnesium, pH, conductivity, turbidity, temperature, redox, nutrients, iron, nitrate, and VOC concentrations will be conducted daily during the radius of influence testing. A downhole probe and data logger will be used to measure dissolved oxygen concentrations in groundwater at the monitoring wells.

The groundwater results will be used to assess the rate at which oxygen can be delivered into the aquifer, the length of time required between oxygen additions to the aquifer, and the area the oxygen sources can effectively treat. The rate at which the oxygen can be delivered will be calculated based on ORC® stability and the length of time required to reach a known distance downgradient. Increases in magnesium and iron hydroxide concentrations and pH shift also will be assessed to determine the impact of ORC® addition to the aquifer.

SECTION 5

PREPARATION OF A RISK ASSESSMENT-BASED CLOSURE/POST CLOSURE PLAN

This section outlines the primary objectives and approach for establishing a risk assessment-based closure/post closure plan using the information generated from the field investigations described in Section 4.

5.1 OVERVIEW OF RISK ASSESSMENT BASED REMEDIATION

Although the complexity of risk-based remediation will vary from one site to another, there are several common elements among all risk-based approaches. Fundamentally, the objective of risk-based remediation is to reduce the risk of specific chemicals to human health, or in some cases to ecological receptors such as animals and plant life. Based on conservative toxicological studies, safe exposures to many chemical compounds such as benzene and vinyl chlorine have been determined. Chemical exposure is generally based on the average intake of a certain mass of chemical per day. The EPA has established different exposure scenarios for different land uses. For example, the residential scenario generally assumes a 24-hour per day exposure while the industrial scenario assumes an 8-hour per day exposure for each worker. Ohio EPA-approved risk algorithms will be used initially to evaluate the commercial and industrial scenarios in the vicinity and downgradient from the HWSA.

For any chemical risk to exist three elements must exist at the site:

- A chemical source which exceeds the safe exposure concentration;
- A completed pathway for the chemical to enter the receptor; and
- A human or ecological receptor available for chemical contact.

If any one of these elements is absent at a site, there is no present risk. The reduction or removal of risk can be accomplished by limiting or removing any one of these elements from the site. The goal of risk-based remediation is to find the most cost-effective method of reducing present and future risk by combining these three risk reduction techniques.

1. **Chemical Source Reduction** - Achieved by natural attenuation processes over time or by engineered removals such as free product recovery, soil vapor extraction, sparging or bioventing.

2. **Chemical Pathway Elimination** - Examples include the natural attenuation of a groundwater plume and restrictions on excavation or groundwater use to prevent on-site or off-site receptors from contacting chemicals of concern. Capping with concrete or asphalt can also be an effective method of pathway elimination.

3. **Restrict Receptors** - Land use controls and site fencing can eliminate chemical exposure until natural attenuation or engineered remediation reduces chemical source.

5.2 SITE SPECIFIC OBJECTIVES

The additional field investigations described in this work plan are intended to meet several specific information gaps that have been identified in the site closure process. The current Closure/Post Closure Plan for Hazardous Waste Storage Area -Bldg. 560 (Parsons ES, 1997) has been approved by the Ohio EPA. To implement a closure plan for contaminated soils and groundwater, the following activities either have been completed, or will be completed in the execution of this work plan.

- Decontamination of Building 560 by cleaning the building and the drum wash pad (completed April 1996);
- Removal of the remaining four USTs (completed February 1995);
- Limited *in situ* remediation of organic soil contamination via passive or air injection bioventing; (proposed testing described in this work plan)
- Natural oxidation of residual dissolved BTEX and natural reductive dehalogenation of residual dissolved chlorinated VOCs (supported by data collected under this work plan);
- *In situ* remediation of residual dissolved chlorinated VOCs via groundwater oxygenation if natural attenuation does not adequately reduce risk, (testing described in this work plan)
- Continued monitoring and site access controls as part of post-closure commitments; and
- Eventual exposure control by installation of taxiway (proposed as future land use).

The primary objective of the site assessment activities proposed in this work plan is to provide information for finalizing the design of the closure approach and for establishing risk assessment-based, long-term performance standards and closure objectives for the site. The data collected during the proposed field activities will be used to accomplish the following four subobjectives:

- Establish a statistically valid sample set which will be used to determine the significance of metals contamination when compared to background levels. Organic contaminant data will also be statistically analyzed to determine the 95 percent UCL. In order to properly address the risks associated with metals on this site, statistically valid background levels must first be established. Similarly, 95 percent UCL levels of organic contaminants will provide a basis for estimating the actual exposure concentrations rather than worst case exposure concentrations.

- Historic organic contaminant data and new data will be analyzed using state of the art fate and transport models and geochemical indicators to estimate the rate at which these contaminants will continue to naturally attenuate. Significant evidence exists that natural biodegradation of both fuel and solvent organics is occurring on this site. Additional sampling of the chlorinated hydrocarbon plume will help to quantify the rate of solvent destruction and to estimate the potential for future plume migration.

- Bioventing, air sparging, and possibly ORC® will be pilot tested at the site to determine both technical feasibility and to determine full-scale design parameters. Test data will be compared to other successful technology demonstrations to determine the expected contaminant removal rates, limitations, and full-scale costs for applications at this site.

- Finally, the preliminary conceptual site model described in Section 3 will be validated or modified based on actual site information. Projected land and groundwater use will be verified. Potential pathways for contaminant migration to receptors will be reevaluated to insure that all potential risks are included in the baseline risk evaluation. Validation of the conceptual site model is critical to this risk assessment-based closure process and Ohio EPA approval of final remediation goals.

5.3 RISK ASSESSMENT-BASED SITE CLOSURE APPROACH

The Ohio EPA authorization and framework to proceed with a risk assessment-based site closure option was described in detail in Section 1.2.3. The Interim Final Guidance for Reviewing Risk-Based Closure Plans for RCRA Units (Ohio EPA, 1993b) provides guidance on generic health-based standards and procedures for establishing site-specific health-based standards for contaminated media which is left in place at a RCRA unit. The Air Force intends to use historic and new site information to pursue a risk assessment-based closure approach which is consistent with this Ohio EPA guidance. The primary components of the Air Force risk-based remediation approach are discussed in this section.

In an effort to reduce the cost and time of cleaning up fuel contaminated sites, the Air Force has developed a streamlined remediation approach that is comprised of several key elements:

- Chemical-Specific Cleanup Standards Based on Site-Specific Risk Reduction,

- Scientific Documentation of Natural Attenuation, and

- Low-Cost Technologies for Contaminant Source Reduction

The coordinated use of these key elements will result in more achievable cleanup standards and the maximum use of natural attenuation, bioventing and other low-cost cleanup techniques.

5.3.1 Chemical-Specific Cleanup Standards

Although most fuels and solvents contain multiple hydrocarbon compounds, a relatively small number of these compounds are known carcinogens or are highly toxic to humans. Once COPCs are identified, the risk-based approach focuses site characterization, fate and transport evaluations, risk exposure calculations and technology selection to specifically address these COPCs. The risk-based approach for remediation of metals, fuel hydrocarbons and solvents is focused on limiting the movement and concentration of these compounds in the environment.

Over the past three decades, EPA has sponsored toxicity studies to determine what relationship, if any, there is between exposure to specific chemicals and the occurrence of cancer or other health problems. These studies have also attempted to estimate the relative risk of cancer based on exposure to relatively low concentrations of these chemicals over long periods of time. "Safe" exposure concentrations developed in these studies provide a benchmark for setting site cleanup goals. Because the type of land use (industrial, commercial, residential) will determine the length and type of chemical exposure, the allowable cleanup standard can generally increase as the duration of potential exposure decreases.

5.3.2 Scientific Documentation of Natural Attenuation

Perhaps the most significant remediation breakthrough in the past five years has been the growing evidence that natural biodegradation is a major factor in the reduction of COPCs and risk at fuel and solvent contaminated sites. Initial data collected from the HWSA indicates that natural attenuation of both fuels and chlorinated solvents is occurring in groundwater and possibly in site soils. The contribution of natural attenuation to overall site risk reduction will be estimated using data collected in the upcoming field investigation. The role of natural attenuation will be quantified using the procedures outlined in most recent AFCEE Intrinsic Remediation Technical Protocols (Wiedemeier *et al.*, 1995; Wiedemeier *et al.*, 1997) for both fuels and chlorinated solvents. The natural attenuation of metals is a highly documented process and is known to limit metals migration in groundwater and surface water. The ability of natural attenuation to contain contaminants and reduce the risk of COPCs at this site will be evaluated for every potential exposure pathway.

5.3.3 Low-Cost Technologies for Source Reduction

At sites with significant soil contamination or free-phased fuel or solvents, natural attenuation processes are often too slow to reduce risk within a reasonable timeframe. At these sites, a more active source reduction technology will be required to reduce the mass of COPCs and to enhance and accelerate natural COPC destruction. Several technologies have been widely tested by the Air Force to meet the need for source reduction. The Air Force bioventing initiative demonstrated that this low-cost

technology was effective at reducing BTEX concentrations in the soil by over 90 percent when applied for one year at over 100 test sites. The use of sparging and oxygen release agents to enhance natural biodegradation has also been effective in sandy aquifers. The results of the proposed bioventing, sparging, and possible use of oxygen release agents will be evaluated to determine the benefits of active remediation methods in reducing risk and the timeframe for long-term monitoring. Performance goals for source reduction technologies will be based on attainment of generic or site-specific, health-based cleanup standards.

5.4 Amended Closure/Post Closure Plan

Following the collection and evaluation of this additional data, the closure/post closure plan for the HWSA will be amended. This amendment will document the risk assessment-based remediation approach and will:

- Summarize new findings on the nature and extent of soil and groundwater contamination;
- Assess statistical background levels of metals in soil and groundwater and establish 95 percent UCLs for other COPCs;
- Provide a quantitative estimate of natural attenuation rates for COPCs and their likelihood of further migration away from the source area;
- Report on the effectiveness of bioventing, sparging and other potential source reduction technologies;
- Develop a quantitative risk assessment and appropriate health-based cleanup goals for this site that are consistent with its intended commercial and industrial use;
- Assess the effectiveness of natural attenuation and engineered remediation methods for achieving appropriate health-based performance goals; and
- Provide an evaluation of natural attenuation/engineered remediation alternatives and recommend the alternative which provides most cost-effective risk reduction for this site.

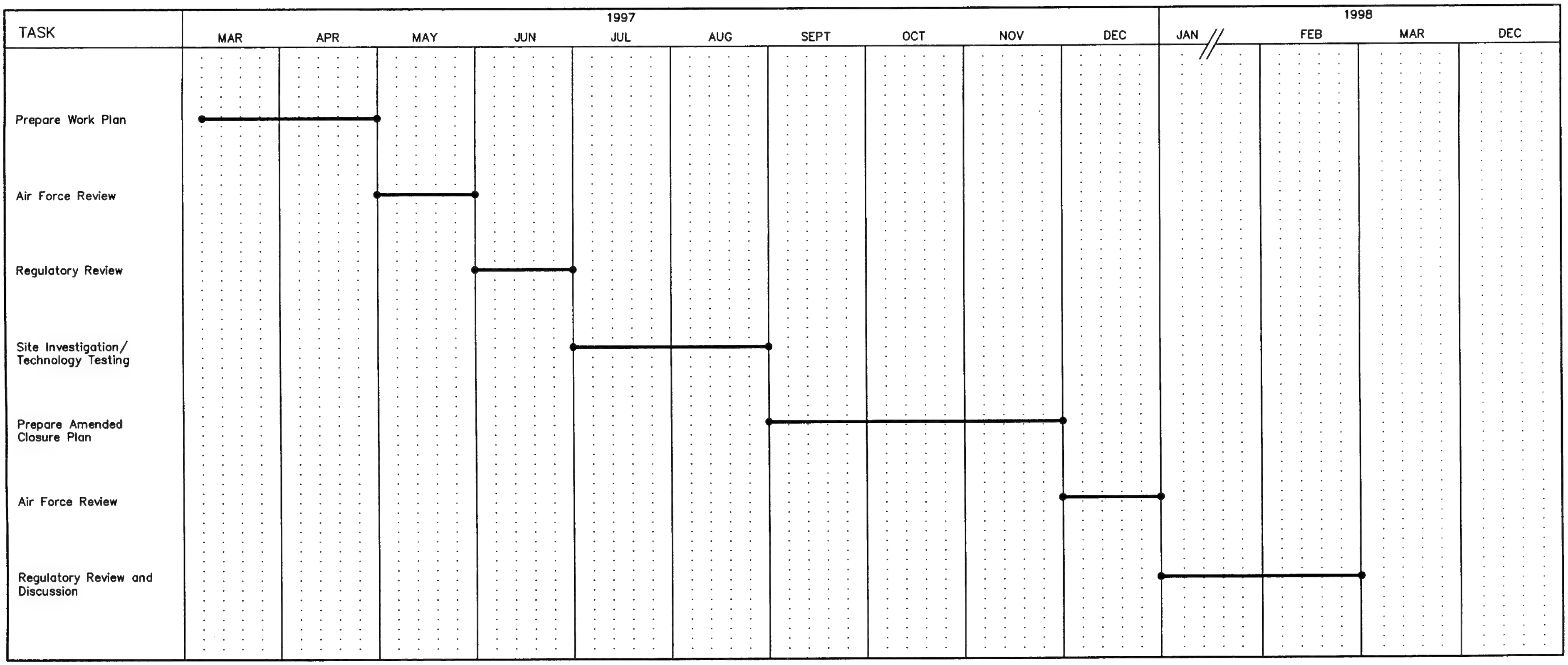
SECTION 6

PROPOSED PROJECT SCHEDULE

The following timeline details the proposed duration of and date of completion for each of the major tasks involved in work plan review, field sampling, data analysis, and completion of an amended Closure/Post Closure Plan for Hazardous Waste Storage Area (Building 560). Each of these major tasks is described in other sections of this work plan.

FIGURE 6.1

ADDITIONAL ASSESSMENT ACTIVITY
HWSA, RICKENBACKER ANGB, OHIO



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SECTION 7

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APPENDIX A

SITE SAMPLING AND ANALYSIS PLAN

1.0 INTRODUCTION

This sampling and analysis plan describes the field procedures that will be followed at the HWSA for the collection of soil gas and groundwater samples from temporary soil gas probes and well points. Monitoring well installation procedures are also described. The installation procedures for the bioventing and air sparge wells will be the same except the construction will differ as specified in Section 4.0 of the work plan. Procedures for collection of soil gas samples from permanent monitoring points and collection of groundwater samples from permanent monitoring wells are specified in the *Amended Closure/Post-Closure Plan* (Parsons ES, 1997) and are incorporated into this plan by reference.

2.0 SOIL GAS SAMPLING

Soil gas sampling will be used delineate the extent of hydrocarbon contamination in vadose zone soils and to assess the effectiveness of *in situ* soil remediation (e.g., bioventing) and groundwater oxygenation (i.e., biosparging) operations in removing source contamination at the site.

The soil gas samples will be collected from temporary soil gas probes for delineation of the extent of soil contamination and from permanently installed monitoring points for evaluation of the bioventing and air sparging pilot tests.

Soil Gas Sampling From Temporary Soil Gas Probes

Soil gas samples will be collected from approximately 10 locations in the vicinity of a previously collected soil sample (HB-1) to characterize the nature and extent of contamination. The samples will be collected using temporary soil gas sample probes equipped with flexible tubing that extends down the rod to the tip of the probe. The soil gas samples will be collected from a depth of approximately 4 feet. Prior to sample collection, the probe will be purged using a vacuum pump. Samples will be collected in Tedlar® bags placed in a vacuum chamber/desiccator. The samples will be screened using a PID. If screening indicates soil contamination, a second sample will be collected for analysis of Halogenated VOCs and BTEX by Methods 8010 and 8020 using the mobile laboratory.

Soil Gas Sampling From Permanent Monitoring Points

Soil gas sampling will be conducted at several newly installed monitoring points (and groundwater monitoring, air sparging, and vent wells with unsaturated screen when possible). The soil gas samples from the permanent monitoring points will be collected and analyzed according to the specifications in Section 6.1.2, Soil Gas Sampling Procedures, of the *Amended Closure/Post-Closure Plan* (Parsons ES, 1997).

3.0 WELL POINT SAMPLING

Groundwater samples will be collected near the downgradient edge of the VOC plume at the site to delineate the extent of groundwater contamination. Approximately five boreholes will be drilled to a depth of approximately 24 feet using direct push drilling techniques. The boreholes will be drilled to the top of the gray basal till. The holes will be continuously cored using Geoprobe® MacroCore® samplers with polyethylene terephthalate (PETG) liners. The soil samples will be used log the lithology of each borehole and to determine the placement of the well points. The soil core will be logged using the Unified Soil Classification System. Soil samples will be collected for headspace analysis from two-foot intervals from the portions

of the soil borings that are above the water table. Soil samples will not be collected for laboratory analysis.

It is estimated that two groundwater samples will be collected from each borehole. The samples will be collected from the two sand and gravel zones present at the site. The water samples will be collected using a Geoprobe® screen point sampler or equivalent. The screen will be set at depths of approximately 13 to 16.5 feet and 20.5 to 24 feet. The water sample from the upper zone will be collected prior to extending the borehole to the deeper zone. The water samples will be collected using a peristaltic pump connected to Teflon®-lined tubing. New tubing will be used for each sample. The groundwater samples will be analyzed for halogenated VOCs and BTEX by Methods 8010 and 8020 using the mobile laboratory.

Boreholes will be advanced using 2-inch ID by 4-foot lead samplers and drive-shoes and 1-inch probe rods through the application of downhole pressure. Each soil boring will be continuously sampled by advancing the lead sampler and drive shoe at 4 foot increments until target depth or refusal. Borings will be open only as long as necessary to collect the soil and groundwater samples. Borings will be abandoned by backfilling from the ground surface with granular bentonite.

Groundwater samples will be collected from screen point samplers. Screen point samplers consist of a wire-wound stainless steel screen (0.004-inch slot) sealed inside a stainless steel sampler sheath. The sampler will be driven to the bottom of the interval to be sampled. The assembly will then be disengaged and the sampler sheath pulled back, exposing the screen. Groundwater will be recovered using disposable polyethylene tubing and a peristaltic pump. The tubing will be inserted into the bore of the screen and then attached to the pump. Low flow pumping rates will be maintained to minimize agitation of suspended solids in the screen point. A maximum of two hours will be devoted to obtaining a groundwater sample at each Geoprobe location and depth. After two hours of effort, no further samples will be collected. The screen points will not be purged prior to sampling.

Groundwater samples will be collected directly from the disposable polyethylene tubing. When collecting the sample, the pumping rate will be lowered to minimize turbulence and aeration of the sample. VOA bottles will be filled until a positive meniscus is achieved above the rim of the sample bottle. The bottles will be immediately capped and then gently tapped to verify that no air bubbles are present in the sample. If bubbles are detected, the bottle will be refilled. Collected samples will be labeled and will be placed on ice if not immediately analyzed.

4.0 MONITORING WELLS

The monitoring wells will be installed in accordance with the AFCEE Handbook (Section 2.1.2.1). Installation of each monitoring well will be performed by using cleaned and decontaminated equipment per procedures outlined in Section 7.0. The monitoring wells will be installed using Rotasonic drilling methods.

The Rotasonic drilling technique uses simultaneous high-frequency vibrational and low speed rotational motion to advance the cutting edge of a hollow circular drill stem. This dual action creates a uniform borehole while providing relatively continuous cores of both unconsolidated and consolidated material. During the drilling process, minimal amounts of drill cuttings, mixed with drilling fluid (potable water), are generated. The Rotasonic rig will push a 4-inch inside diameter (ID) core barrel for sampling inside of a 6-inch ID drive casing. The core barrel will be advanced ahead of the drive casing, generally in 5 to 20 foot

increments to collect samples from undisturbed soils. After advancement of the core barrel, the drive casing will be advanced to just ahead of the leading edge of the core barrel using potable water as a drilling fluid. The core barrel will then be removed from the borehole.

Soil sampling will be conducted using continuous core sampling in advance of drilling. After the core barrel is retrieved, the soil core will be extruded from the barrel into a protective plastic sleeve for handling. The soil core will be extruded by applying vibrational energy and water pressure to the core barrel through the drill head. The extruded core will then be screened with a photoionization detector (PID) along its entire length (through the sleeve) before the plastic sleeve is opened for sampling. The soil core will be logged using the Unified Soil Classification System. Soil samples will be collected for headspace analysis from two-foot intervals from the portions of the soil borings that are above the water table. Soil samples will not be collected for laboratory analysis from borings for the new groundwater montioring wells. For the borings for the bioventing well, bioventing monitoring wells, air sparge well, and air sparge monitoring wells, one composite sample soil sample will be collected from each screen interval. The soil samples from the bioventing wells will be tested for ammoniacal nitrogen, ortho-phosphate, soil moisture, pH, TPH (gasoline and diesel range), VOCs, SVOCs, TAL metals, microbial enumerations, and bulk density. The soil samples from the air sparge wells will be tested for total iron, ammoniacal nitrogen, ortho-phosphate, soil moisture, pH, VOCs, and microbial enumerations.

Groundwater monitoring wells will be installed across two thin water bearing sand and gravel zones. The screened intervals will consist of silty clays, clayey silts, and fine to medium grained silty/clayey sands and gravels. Based on the filter pack and well screen selection criteria described in the OEPA Technical Guidance Manual for Hydrogeologic Investigations and Groundwater Monitoring, this type of formation requires a filter pack and well screen design consisting of a filter pack with a 40-140 mesh size and a 0.005-inch (or smaller) slot screen. However, this well design would not allow the finer grained portion of the formation to pass through the filter pack during well development. This would cause clogging of the filter pack and well screen and lower the hydraulic conductivity of the filter pack.

To avoid the above problems, based on practical application of well design criteria in central Ohio, well construction will consist of #8 (20-40 mesh) sand and a 0.010-inch slot screen, which will provide the most efficient monitoring well in the formation. This design will allow a maximum retention of the formation after development (allowing the fine grained material around the filter pack to be removed during development), while also providing sufficient hydraulic conductivity in the filter pack.

The monitoring wells will be constructed using flush-threaded two-inch diameter Schedule 40 Polyvinyl Chloride (PVC) casing and screen. The well screen will be five feet long with 0.010 inch continuous slotted PVC screen placed across the sand and gravel water bearing zone. The bottom of the screen will be capped. The annular space will be filled with clean #8 silica sand to approximately 1 foot above the top of the screen followed by approximately two feet of bentonite pellet seal. During placement of the sand, the 6 inch drive casing of the Rotasonic drilling will be vibrated to insure that no bridging of the sand occurs. After the filter pack is emplaced, the well will be surged with a surge block for ten minutes. Following the verification of the top of the sand pack, the bentonite seal will be placed. The remaining annulus will be grouted to the surface using a 100% bentonite grout or pellets.

Surface completion of monitoring wells will be based on location. If above-ground completion (stick-up) is not feasible, flush-to-ground surface completion will be used. When

an above-ground surface completion is used, well casing will be extended two to three feet above land surface. A six-inch diameter steel protective casing with a lockable hinged cap will be set into the grout. If specified by the AFCEE Field Engineer, three 3-inch diameter concrete-filled steel guard posts five feet in total length, with two feet below ground around the well to protect the casing. When flush-to-ground completion is installed, the casing will be cut about three inches below the land surface and furnished with a water-tight casing cap. A freely draining valve box with a locking cover will be placed over the casing. A cement pad (3 x 3 x 0.5 feet) will be placed around the base of the protective casing. The well identification will be permanently marked on the casing cap and the protective casing. A permanent notch in the top of the inner casing will be marked as a measuring point for water levels. A monitoring well installation sheet will be completed for each well (Attachment A).

Monitoring Well Development

Development of newly installed wells will begin no sooner than 24 hours after installation to allow for grout curing. Surge blocks and bailers or pumps may be used for development. During development discharge (pumping) rates will be measured using a graduated container (i.e., plastic bucket) prior to containerization. Development will continue until the turbidity is ≤5 nephelometric turbidity unit (NTU), and when the stabilization of pH, temperature and specific conductance has occurred. Stabilization is defined in the AFCEE Handbook (Section 2.1.3.2) as pH within 0.1 unit, temperature within 1 degree centigrade, and specific conductance within 5 percent. In some instances, collection of non-turbid samples are difficult or unattainable. If a well does not provide a sediment-free sample, development will stop when:

- A maximum of 10 well volumes have been removed, in addition to any volume of water or fluid that may have entered the well and formation during construction and/or
- Temperature, conductivity, and pH have stabilized to the above criteria over at least three successive well volumes, and the turbidity remains within a 10 NTU range for at least 30 minutes.

In other instances, a well may be purged dry during development. In such cases, the water level will be allowed to recharge to at least fifty percent of the static water level, and the well will be purged dry a total of three times. After each recharge, the above parameters will be measured to confirm stabilization. If stabilization does not occur, the well will be sampled after the third purge and conditions highlighted in the field log.

No detergents, soaps, acids, bleaches, or other additives will be used to developed a well. All development equipment will be decontaminated according to the specifications documented in Section 7.0. A monitoring well development/purge log will be completed for each well (Attachment A).

Monitoring Well Sampling

The monitoring wells will be sampled as part of the RCRA quarterly monitoring at the HWSA. The procedures to be followed for monitoring well sampling are specified in Section 6.3, Groundwater Sampling, of the *Amended Closure/Post-Closure Plan* (Parsons ES, 1997).

5.0 ANALYTICAL PROCEDURES

Mobile Laboratory

A mobile laboratory will be used for the analysis of soil gas samples and groundwater samples by gas chromatography. The analyses will be performed with all QC procedures normally associated with the methods when performed in a fixed-base laboratory including multiple point calibrations, spikes, blanks, and duplicates.

Samples will be analyzed per procedures specified in SW-846 Methods 8000, 8010 and 8020. SW-846 Method 8021, which combines Methods 8010 and 8020, may be run in lieu of separate Method 8010 and 8020 analyses.

Target Compounds and Detection Limits

The analytes and detection limits are listed on Tables A-1 and A-2. Detection limits are matrix dependent but the mobile laboratory should be able to obtain the specified detection limits under normal operating conditions. Note that cis-1,2-dichloroethene has been added to the list of analytes for Method 8010.

Analytical Sequence

The analytical sequence for day to day operations will be as follows:

1. Instrument blank;
2. Initial calibration standard;
3. Laboratory (syringe) air sample;
4. Samples (including Field & Lab QC samples);
5. Continuing calibration standard.

Quality Control Samples

Field and laboratory QC samples that will be analyzed are one field duplicate per ten environmental samples, one laboratory replicate analysis per ten environmental samples, one matrix spike and one matrix spike duplicate per 20 environmental samples (groundwater samples only), and one rinse blank per day of sampling (groundwater samples only).

Record Keeping

Logbooks

Sequentially numbered logbooks will be maintained in the field laboratory to record details of the analytical work. One logbook will be maintained for sample preparation information and another will be used as a GC analysis run log. The sample preparation logbook will include information such as date sample, date analyzed, and injection volume. The analytical run logbook will provide a description of what was being analyzed, injection time, file name, and a comment section to record maintenance information as well as extra sample information. Logbook pages will be signed and dated by the analyst.

Table A-1

Halogenated Volatile Hydrocarbons
By Gas Chromatography
Method 8010B/8021A

Compound	Reporting Limit (ug/l)
Allyl chloride	1
Benzyl chloride	1
Bis(2-chloroethoxy)methane	1
Bis(2-chloroisopropyl)ether	1
Bromoacetone	1
Bromobenzene	1
Bromodichloromethane	1
Bromoform	1
Bromomethane	1
Carbon tetrachloride	1
Chlorobenzene	1
Chloroethane	1
2-Chloroethanol	1
2-Chloroethyl vinyl ether	1
Chloroform	1
1-Chlorohexane	1
Chloromethane	1
Chloromethyl methyl ether	1
Chloroprene	1
4-Chlorotoluene	1
Dibromochloromethane	1
1,2-Dibromo-3-chloropropane	1
Dibromomethane	1
1,2-Dichlorobenzene	1
1,3-Dichlorobenzene	1
1,4-Dichlorobenzene	1
1,4-Dichloro-2-butene	1
Dichlorodifluoromethane	1
1,1-Dichloroethane	1
1,2-Dichloroethane	1
1,1-Dichloroethene	1
cis-1,2-Dichloroethene*	1
trans-1,2-Dichloroethene	1
Dichloromethane	1
1,2-Dichloropropane	1
1,3-Dichloro-2-propanol	1
cis-1,3-Dichloropropene	1
trans-1,3-Dichloropropene	1
Epichlorhydrin	1
Ethylene dibromide	1
Methyl iodide	1
1,1,2,2-Tetrachloroethane	1
1,1,1,2-Tetrachlorethane	1
Tetrachloroethane	1
1,1,1-Trichloroethane	1
1,1,2-Trichloroethane	1
Trichloroethene	1
Trichlorofluoromethane	1
1,2,3-Trichloropropane	1
Vinyl Chloride	1

* - Project specific addition to 8010 list

Table A-2

Aromatic Volatile Hydrocarbons
By Gas Chromatography
Method 8020A/8021A

Compound	Reporting Limit (ug/l)
Benzene	1
Chlorobenzene	1
1,4-Dichlorobenzene	1
1,3-Dichlorobenzene	1
1,2-Dichlorobenzene	1
Ethyl Benzene	1
Toluene	1
Xylenes	1

Chromatograms

The following information must be included on each chromatogram:

1. Site name;
2. Sample description including sample # and type;
3. Injection volume;
4. Software filename under which the chromatogram will be placed on to disk;
5. Date and time of sample injection;
6. Detector represented.

Deliverables and Data Storage

Daily summary reports will be provided to the field operations leader within 24 hours of sample collection. The report will include calibration RPDs, blank results, sample results, and duplicate results.

Fixed Base Laboratory

The analytical procedures for soil gas and groundwater samples to be analyzed by a fixed base laboratory are specified in Sections 6.1 and 6.3 of the *Amended Closure/Post-Closure Plan* (Parsons ES, 1997)

6.0 SURVEYING

The horizontal and vertical locations of each soil gas point, geoprobe well point, bioventing well, sparge well, and monitoring well will be surveyed by a professional licensed surveyor. The horizontal location of each point will be reported to the nearest foot using the Ohio State Plane coordinate system. The vertical elevation of each point will be reported to the nearest 1/100 foot using the National Geodetic Vertical Datum of 1983.

7.0 DECONTAMINATION PROCEDURES

Water to be used in equipment cleaning will be obtained from one of the base's onsite water supplies. Rickenbacker ANGB personnel will assist field personnel in locating a suitable source. Water use approval will be verified by contacting the appropriate facility personnel. Only potable water will be used for decontamination. A decontamination water blank will be collected from the potable water source. The field hydrogeologist will make the final determination as to the suitability of site water for these activities.

All sampling tools will be cleaned with a clean water/phosphate-free detergent mix, a clean water rinse, and a final distilled water rinse. Rotasonic drill rig equipment will be cleaned with a hot water pressure washer prior to use at each monitoring well location. Equipment that cannot be cleaned to the satisfaction of the field scientist will not be used. All decontamination activities will be conducted in a manner so that the excess water will be controlled and not allowed to flow into any open borehole.

Fuel, lubricants, and other similar substances will be handled in a manner consistent with accepted safety procedures and standard operating practices. The Geoprobe® and Rotasonic Drill Rig will not be allowed onsite unless they are free from leaks in all hydraulic and fuel lines, and are free of any exterior oil and grease.

Surface runoff such as miscellaneous spills and leaks, precipitation, and spilled decontamination fluids will not be allowed to enter any boring. Berms around the borehole and surficial bentonite packs, as appropriate, will be used to prevent cross-contamination.

Water used to decontaminate sampling equipment will be drummed and analyzed for off site disposal.

8.0 WASTE DISPOSAL

Soil cuttings, decontamination water, and groundwater generated during well and well point purging will be drummed and analyzed for disposal. If hazardous waste constituents are not detected in the material it will be disposed of as non-hazardous. If hazardous waste constituents are detected, the waste will be characterized as hazardous. The disposal method of any hazardous waste will be determined by the concentrations of the hazardous constituents relative to the RCRA treatment standards.

ATTACHMENT A

FIELD FORMS

INTERNATIONAL TECHNOLOGY CORPORATION

Well Completion Information

RANGB, Ohio

PROJECT: 762970 DELIVERY ORDER 0030

LOCATION ID: __________ (Well Number)

DATE INSTALLED: ☐☐/☐☐/☐☐ (MM/DD/YR)

WELL OWNER: USAF ______ (other) WELL CLASSIFICATION: WL

COMPLETION METHOD: GS

GEOLOGIC ZONE: A L C P S ? U W

SOLE SOURCE AQUIFER: UNK _____ (other)

SEAL START DEPTH: _________ (XXXX.XX in feet)

SEAL END DEPTH: _________ (XXXX.XX in feet)

FILTER PACK START DEPTH: ___________ (XXX.XX in feet)

FILTER PACK END DEPTH: ___________ (XXX.XX in feet)

MEASURING PT ELEVATION (Top of Casing): ________________ (XXXXX.XX)

TOTAL CASING DEPTH: _____________ (XXX.XX in feet)

CASING INSIDE DIAMETER: _______ *Should be smaller than the borehole diameter on New Location Log.

CASING MATERIAL: PVC SLS GLS _______ (other)

SCREEN START DEPTH: _______________ (XXXX.XX is feet)

SCREEN END DEPTH: _______________ (XXXX.XX is feet)

SCREEN SLOT SIZE: _____________ (XXX.XX in inches)

SCREEN DIAMETER: _____________ (XXX.XX in inches)

PERCENT OPEN AREA: _______________ (XX.X)

REMARKS:

Prepared By: ______________________

INTERNATIONAL TECHNOLOGY CORPORATION

Groundwater Well Development/Purge Log

RANGB, Ohio

PROJECT 762970 DELIVERY ORDER 0030

SITE ID: **LOCATION ID:** ______________ (Well Number) Target Purge Volume : _________ gal

Purging Method/Equipment: ____________________________________ Sampling Equipment/ID No:__________________________

Well Casing Diameter : _________________ in. Unit Casing Volume (UC): ___________________ gal.

Sounding (Depth to Well Bottom): ___________________ **Static Water Level** (Depth to Water): ___________________

Date	Time 24hr	Recovery Time (min)	Purge Rate (gal/min)	Dynamic H2O Level (ft)	Volume Purged (gl)	Temp C°	pH	Cond. ____	Turbidity (NTU)	Dry (Y/N)	Pump or Slug (P/S)	Water Description
	:											
	:											
	:											
	:											
	:											
	:											
	:											
	:											
	:											
	:											
	:											
	:											
	:											

Recovery Depth* (ft from TOC) : _______ Final **Recovery Time*** (min) : _________ * Taken As Final Water Level Reading and Time after sampling is complete and well has recovered.

Prepared by: ________________________________

Date	Time 24hr	Recovery Time (min)	Purge Rate (gal/min)	Dynamic H2O Level (ft)	Volume Purged (gl)	Temp C°	pH	Cond. _____	Turbidity (NTU)	Dry (Y/N)	Pump or Slug (P/S)	Water Description
	:											
	:											
	:											
	:											
	:											
	:											
	:											
	:											
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INTERNATIONAL
TECHNOLOGY
CORPORATION

Groundwater Sample Collection Log

RANGB, Ohio

PROJECT: 762970 DELIVERY ORDER 0030

SITE ID:

LOCATION ID: ______________ **SAMPLE #:** ____________________

LOG DATE: ☐☐/☐☐/☐☐ **LOG TIME:** ☐☐☐☐ (HHMM)

SAMPLE BEGINNING DEPTH: 0 **SAMPLE ENDING DEPTH:** 0

CONTAINERS:

QTY	SIZE	TYPE/Preservation	PARAMETER	METHOD
2	40 ML	VOA/4°C	Volatiles	8010B 8020A

COMMENTS: ____

LOG CODE: ITCO **LOCATION CLASS:** WL

MATRIX: WG **SAMPLING METHOD:** SP

SAMPLE /QC TYPE: ☐☐☐

(N# = Normal, AB# = Ambient Blank, EB#-Equipment Blank, TB# =Trip Blank, FR#-Field Split, MB#=Material Blank)

Enter sample numbers for blanks associated to this sample:

Matrix Spike (MS): ______________ Matrix Spike Dup (SD): ______________ Field Dup(FD): ______________

Ambient Blank (AB): ______________ Trip Blank (TB): ______________ Equipment Blank (EB): ______________

LOT CONTROL #: Ambient Blank #: ☐ Equipment Blank #: ☐ Trip Blank #: ☐ Volatile Cooler #: ☐

SAMPLER: ______________________ PREPARED BY: ______________________

SAMPLER: ______________________ CHAIN-OF-CUSTODY #: ______________

PURPOSE: ______________________ FEDEX Waybill #:

INTERNATIONAL TECHNOLOGY CORPORATION

Rinsate Sample Collection Log

RANGB, Ohio

PROJECT: 762970 DELIVERY ORDER 0030

SITE ID:

LOCATION ID: ______________ **SAMPLE #:** ____________________

LOG DATE: ☐☐/☐☐/☐☐ **LOG TIME:** ☐☐☐☐ (HHMM)

SAMPLE BEGINNING DEPTH: 0 **SAMPLE ENDING DEPTH:** 0

CONTAINERS:

QTY	SIZE	TYPE/Preservation	PARAMETER	METHOD
2	40 ML	VOA/4°C	Volatiles CFC	8010B 8020A

COMMENTS: ____

LOG CODE: ITCO

MATRIX: WH **SAMPLING METHOD:** G

SAMPLE /QC TYPE: E B ☐

Enter sample numbers associated to this sample:

Ambient Blank (AB): ______________ Trip Blank (TB): ______________

LOT CONTROL #: Ambient Blank #: ☐ Equipment Blank #: ☐ Trip Blank #: ☐ Volatile Cooler #: ☐

SAMPLER: ____________________ PREPARED BY: ____________________

SAMPLER: ____________________ CHAIN-OF-CUSTODY # ____________________

PURPOSE: ____________________ FEDEX Waybill # ____________________